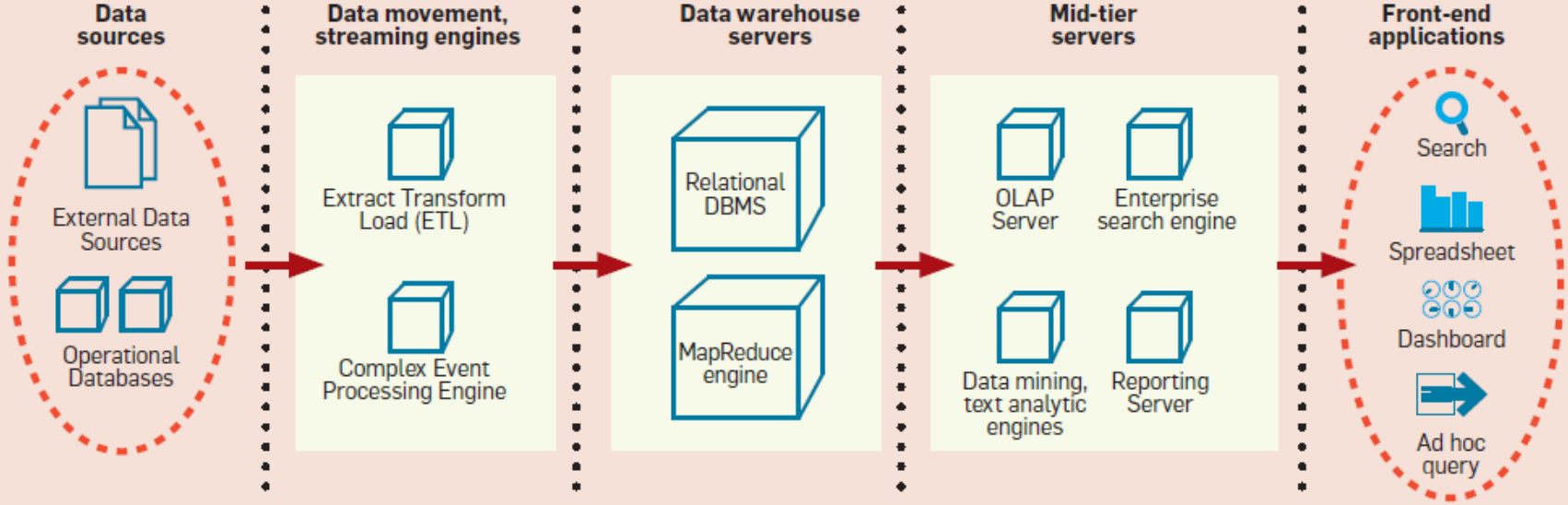
# BUSINESS INTELLIGENCE

## Data Analysis using SQL

# BI Architecture



**Figure 1. Typical business intelligence architecture.**



# DATA ANALYSIS USING SQL

A Data warehouse is all about **getting answers** to business questions, in the form of **reports**.

Reports must communicate pertinent information clearly and concisely.

**Good reporting is imperative**: Even the best schema design cannot guarantee success if answers are not delivered with useful reports.

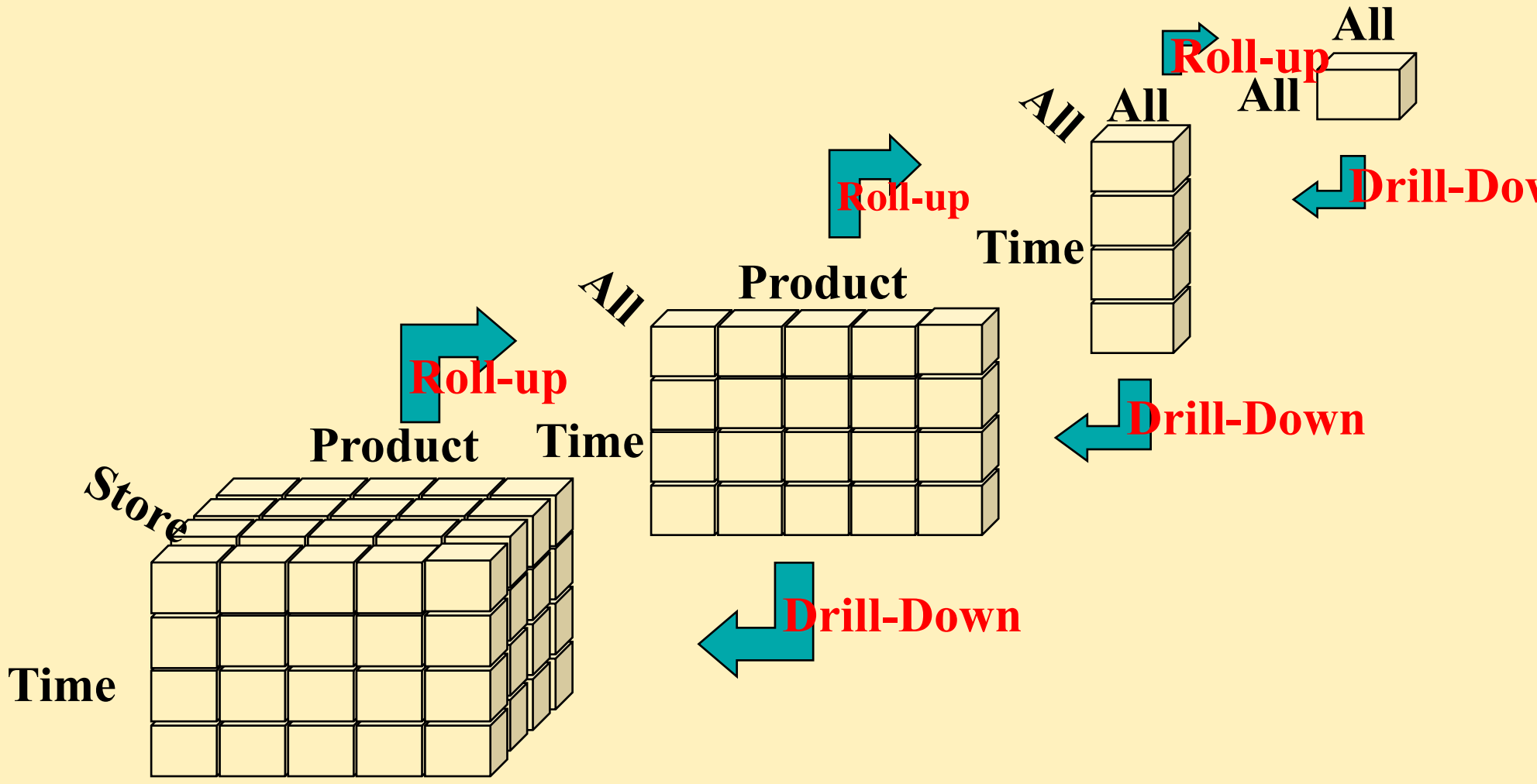
Three ways to **present** information.

- Traditional reports.
- Pivot tables.
- Charts.

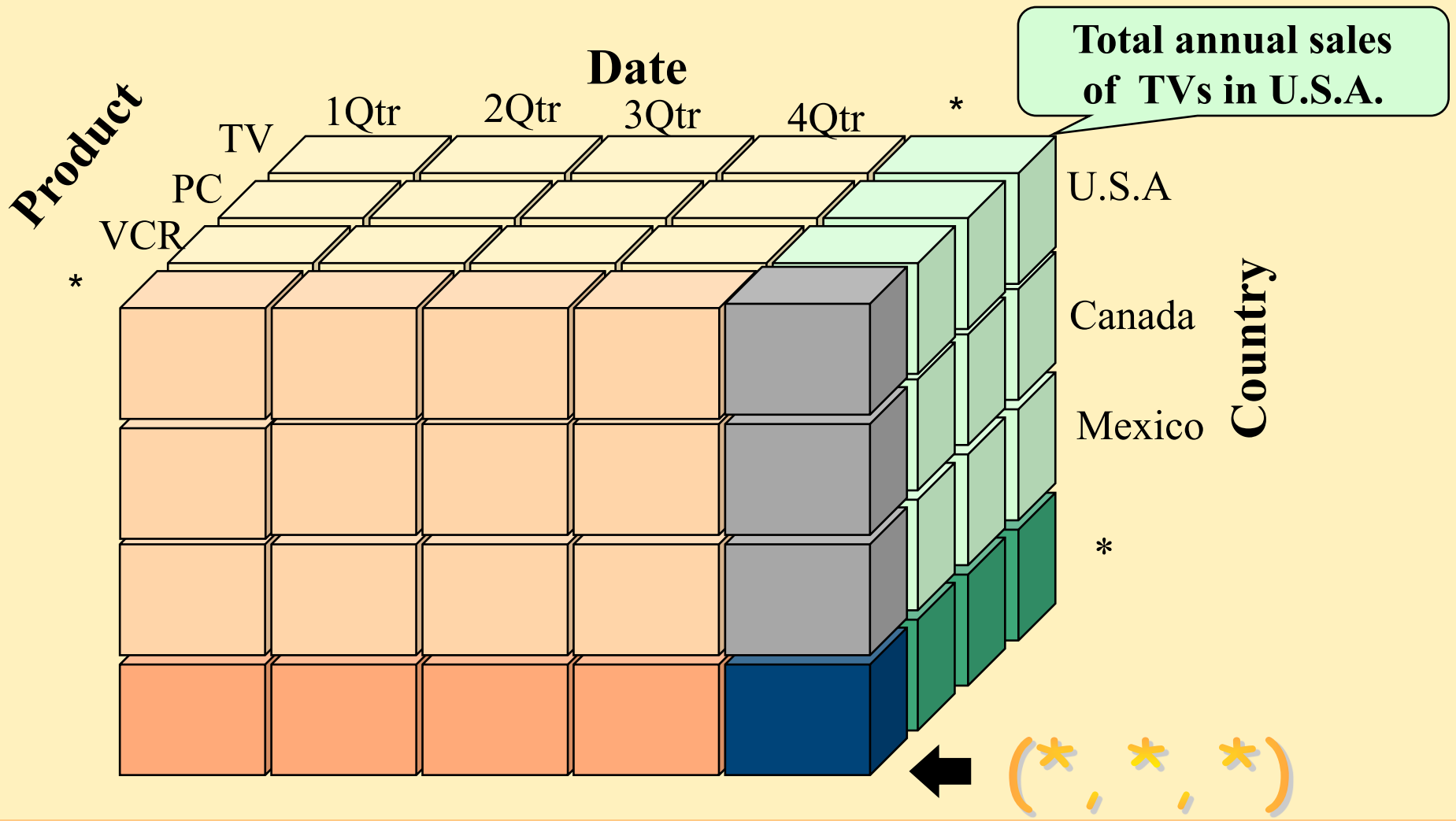
There are several kinds of **reporting tools** on the market.

# Cuboids in SQL

# How many cuboids?



# Data Cube
# (extended cube, hypercube)



# Data cube in SQL Server

Order or pivoting

Aggregate

Measure

```
SELECT L.city, I.brand, T.month, SUM(dollars_sold)
 FROM fact AS F, location AS L, time AS T, item AS I
 WHERE F.location_key = L.location_key AND F.time_key =
   T.time_key AND F.item_key = I.item_key
GROUP BY CUBE(L.city, I.brand, T.month)
```

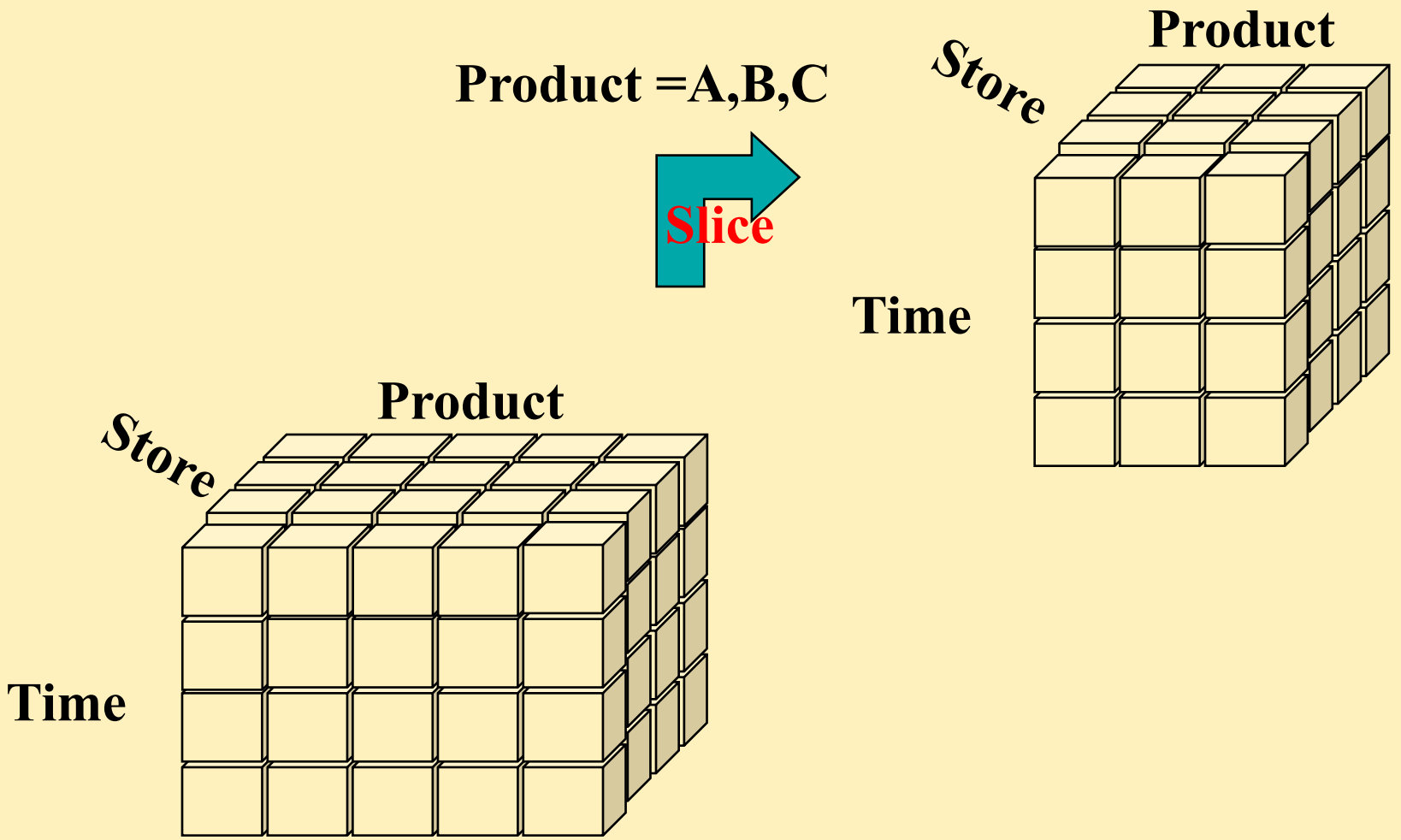
Star-Join

Hierarchy levels

GROUP BY ROLLUP(L.city, I.brand, T.month)
- all initial subsequences of the group-by attributes

# Slice and Dice





# Slice in SQL Server



Order or pivoting

Aggregate

Measure

```
SELECT L.city, I.brand, T.month, SUM(dollars_sold)
 FROM fact AS F, location AS L, time AS T, item AS I
 WHERE F.location_key = L.location_key AND F.time_key =
   T.time_key AND
   F.item_key = I.item_key  AND
  T.year = 2016
GROUP BY CUBE(L.city, I.brand, T.month)
```

Star-Join

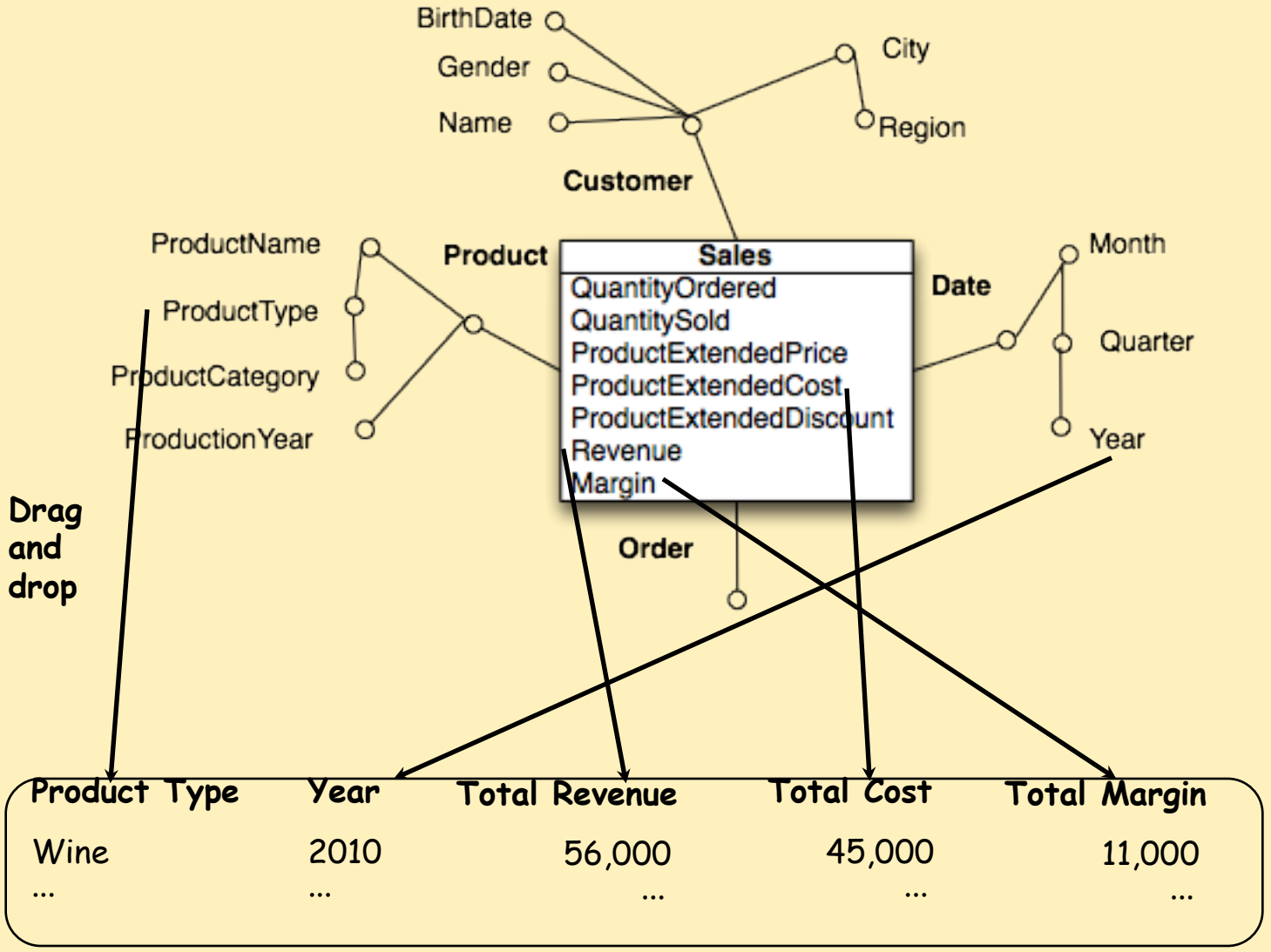
Slice

Hierarchy levels

## Star-join executions in SQL Server

- Star-join optimization
  - automatically detected (vs to be setup in Oracle)
- Bitmap join indexes
  - not available (vs available in Oracle)
- Columnstore indexes (since SQL Server 2012)
  - see docs
    - http://msdn.microsoft.com/en-us/library/gg492088.aspx
  - Example (on a copy of sales_fact)
    - CREATE CLUSTERED COLUMNSTORE INDEX cci_sales ON sales_fact_copy

# REPORTING TOOLS



# SIMPLE REPORTS WITH SQL

**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)

**Margin by Brand and by Product**
**Year 2009**

| Brand | Product | Revenue (€) | Margin (€) | Margin% (%) |
|---|---|---|---|---|
| B1 | P1 | 2 100 | 273 | 13 |
| | P2 | 3 720 | 624 | 17 |
| | P3 | 15 300 | 1 803 | 12 |
| B2 | P4 | 12 600 | 756 | 6 |
| | P5 | 22 500 | 2 196 | 10 |
| | P6 | 48 300 | 4 496 | 9 |

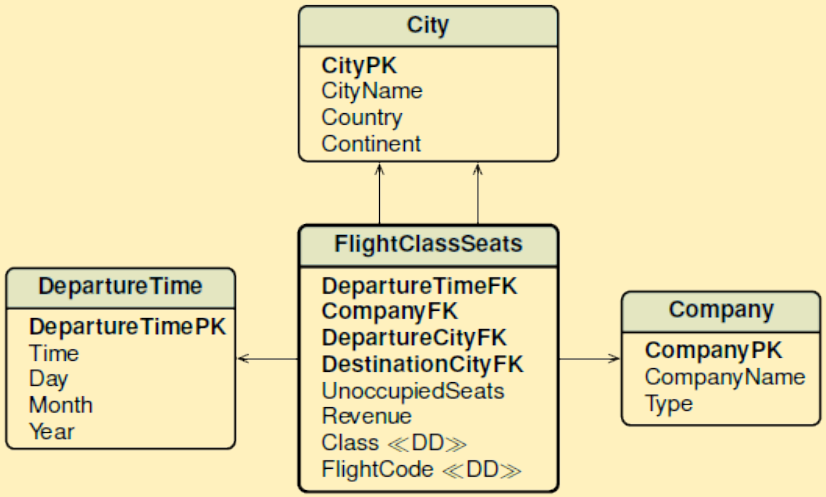
```
SELECT    Brand, Product, SUM(Revenue) AS Revenue,
          SUM(Margin) AS Margin,
          ROUND(100*SUM(Margin)/SUM(Revenue)) AS Margin%
FROM      Sales
WHERE     YEAR(Date) = 2009
GROUP BY  Brand, Product
ORDER BY  Brand, Product;
```

Slice

Rollup & drill-down

Pivoting

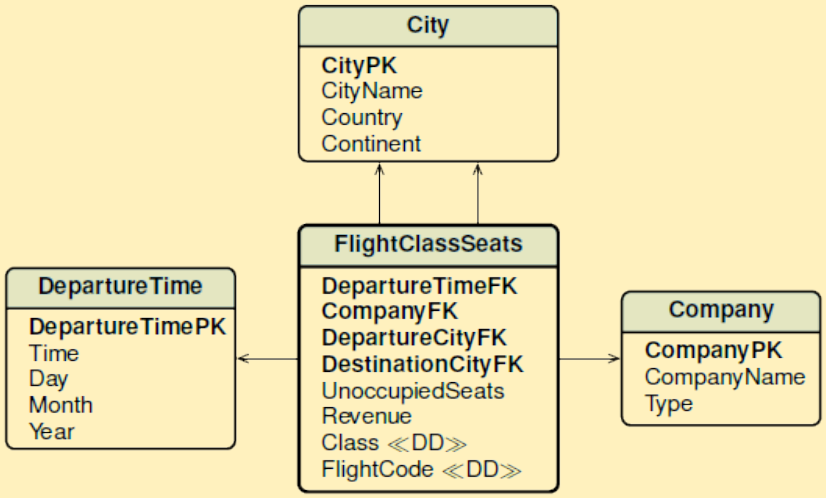
# AIRLINE COMPANIES: DATA ANALYSIS




| Requirements analysis |
|---|
| Number of unoccupied seats in a given year, by flight code, by company name (or type), by class, by departure time (time, day, month, year) |
| Number of unoccupied seats in a given class and year, by flight code, by company name, by class, by departure (destination) city (country, continent). |
| Number of unoccupied seats and revenue of the Alitalia company, by year, by month, by destination country. |

```
SELECT   FlightCode, CompanyName, Class, Time, SUM(UnoccupiedSeats) As TotalUnoccupiedSeats
FROM     FlightClassSeats f, DepartureTime t, Company c
WHERE    f.DepartureTimeFK = t.DepartureTimePK AND f.CompanyFK = c.CompanyPK and year = 2015
GROUP BY FlightCode, CompanyName, Class, Time,
```

# AIRLINE COMPANIES: DATA ANALYSIS




| Requirements analysis |
|---|
| Number of unoccupied seats in a given year, by flight code, by company name (or type), by class, by departure time (time, day, month, year) |
| Number of unoccupied seats in a given class and year, by flight code, by company name, by class, by departure (destination) city (country, continent). |
| Number of unoccupied seats and revenue of the Alitalia company, by year, by month, by destination country. |

```
SELECT  FlightCode, CompanyName, Class, City, SUM(UnoccupiedSeats) As TotalUnoccupiedSeats
FROM    FlightClassSeats f, DepartureTime t, City c
WHERE   f.DepartureTimeFK = t.DepartureTimePK AND f.DepartureCityFK = c.CityPK
          AND Class='Business' AND year = 2015
GROUP BY FlightCode, CompanyName, Class, City

SELECT  year, month, country, SUM(UnoccupiedSeats) As TotalUnoccupiedSeats,
                              SUM(Revenue) As TotalRevenue
FROM    FlightClassSeats f, DepartureTime t, City c
WHERE   f.DepartureTimeFK = t.DepartureTimePK AND f.DestinationCityFK= c.CityPK
            AND CompanyName='Alitalia'
GROUP BY year, month, country
```

# SIMPLE REPORTS WITH SUBTOTALS

**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)

| Margin by Brand and by Product<br>Year 2009 | | | | |
|---|---|---|---|---|
| **Brand** | **Product** | **Revenue (€)** | **Margin (€)** | **Margin% (%)** |
| B1 | P1 | 2 100 | 273 | 13 |
| | P2 | 3 720 | 624 | 17 |
| | P3 | 15 300 | 1 803 | 12 |
| **B1** | **Total** | **21 120** | **2 700** | **13** |
| B2 | P4 | 12 600 | 756 | 6 |
| | P5 | 22 500 | 2 196 | 10 |
| | P6 | 48 300 | 4 496 | 9 |
| **B2** | **Total** | **83 400** | **7 448** | **9** |
| **Total** | | **104 520** | **10 148** | **10** |

# SIMPLE REPORTS WITH SUBTOTALS IN SQL

**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)

Margin by Brand and by Product
Year 2009

| Brand | Product | Revenue (€) | Margin (€) | Margin% (%) |
|---|---|---|---|---|
| B1 | P1 | 2 100 | 273 | 13 |
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| | P6 | 48 300 | 4 496 | 9 |
| **B2** | **Total** | **83 400** | **7 448** | **9** |
| **Total** | | **104 520** | **10 148** | **10** |

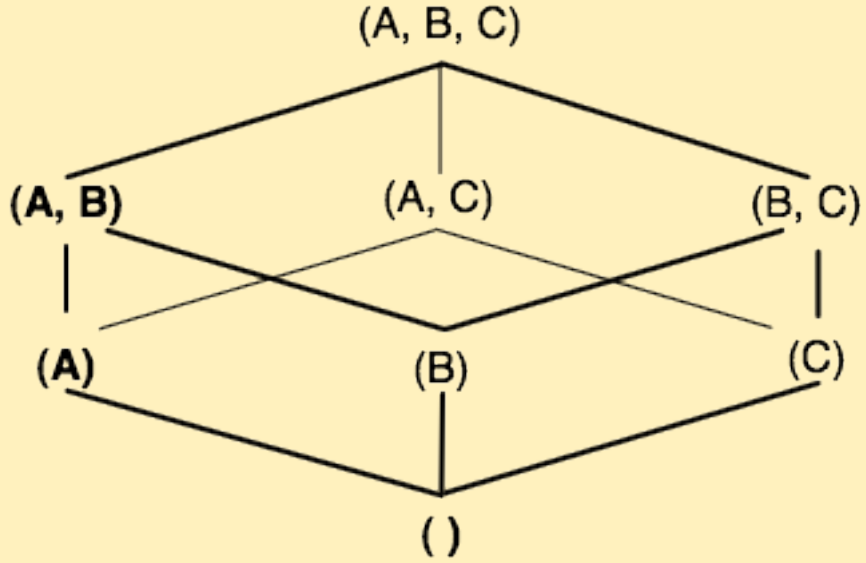
## GROUP BY ROLLUP(A,B)

**Important** the (attributes order)

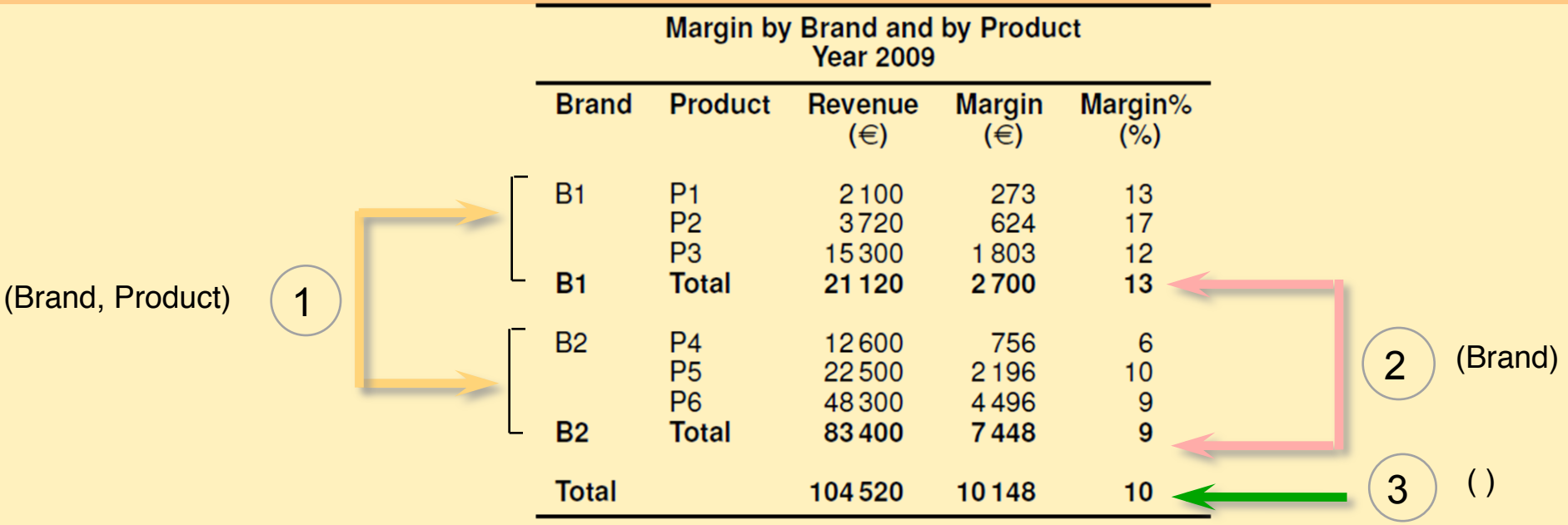
Semantics: Union of 3 groupings:

(A,B)
(A) subtotals
() totals

**ROLLUP** compute one path through lattice



# SIMPLE REPORTS WITH SUBTOTALS: ROLLUP




Margin by Brand and by Product
Year 2009

| Brand | Product | Revenue (€) | Margin (€) | Margin% (%) |
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| **B2** | **Total** | **83 400** | **7 448** | **9** |
| **Total** | | **104 520** | **10 148** | **10** |

```
SELECT    Brand, Product, SUM(Revenue) AS Revenue,
          SUM(Margin) AS Margin,
          ROUND(100*SUM(Margin)/SUM(Revenue)) AS Margin%
FROM      Sales
WHERE     YEAR(Date) = 2009
GROUP BY  ROLLUP (Brand, Product)
ORDER BY  Brand, Product;
```

# SIMPLE REPORTS WITH SUBTOTALS: CROSS-TABULATION

| | Store | | | |
|---|---|---|---|---|
| **Product** | **S1** | **S2** | **S3** | **Total** |
| P1 | 300 | 500 | 50 | **850** |
| P2 | 30 | 50 | 400 | **480** |
| **Total** | **330** | **550** | **450** | **1330** |

**Margin by Brand and by Product**
**Year 2009**

| Brand | Product | Revenue (€) | Margin (€) | Margin% (%) |
|---|---|---|---|---|
| B1 | P1 | 2 100 | 273 | 13 |
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| | P5 | 22 500 | 2 196 | 10 |
| | P6 | 48 300 | 4 496 | 9 |
| **Total B2** | | **83 400** | **7 448** | **9** |
| | **Total P1** | **2 100** | **273** | **13** |
| | **Total P2** | **3 720** | **624** | **17** |
| | **Total P3** | **15 300** | **1 803** | **12** |
| | **Total P4** | **12 600** | **756** | **6** |
| | **Total P5** | **22 500** | **2 196** | **10** |
| | **Total P6** | **48 300** | **4 496** | **9** |
| **Total** | | **104 520** | **10 148** | **10** |

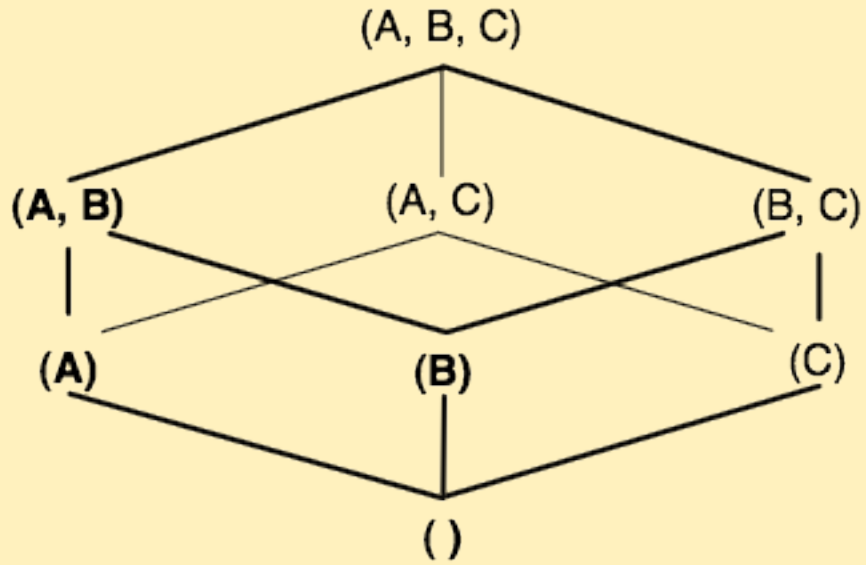
## GROUP BY CUBE(A,B)

**Important:** the (attributes order) **doesn't matter**

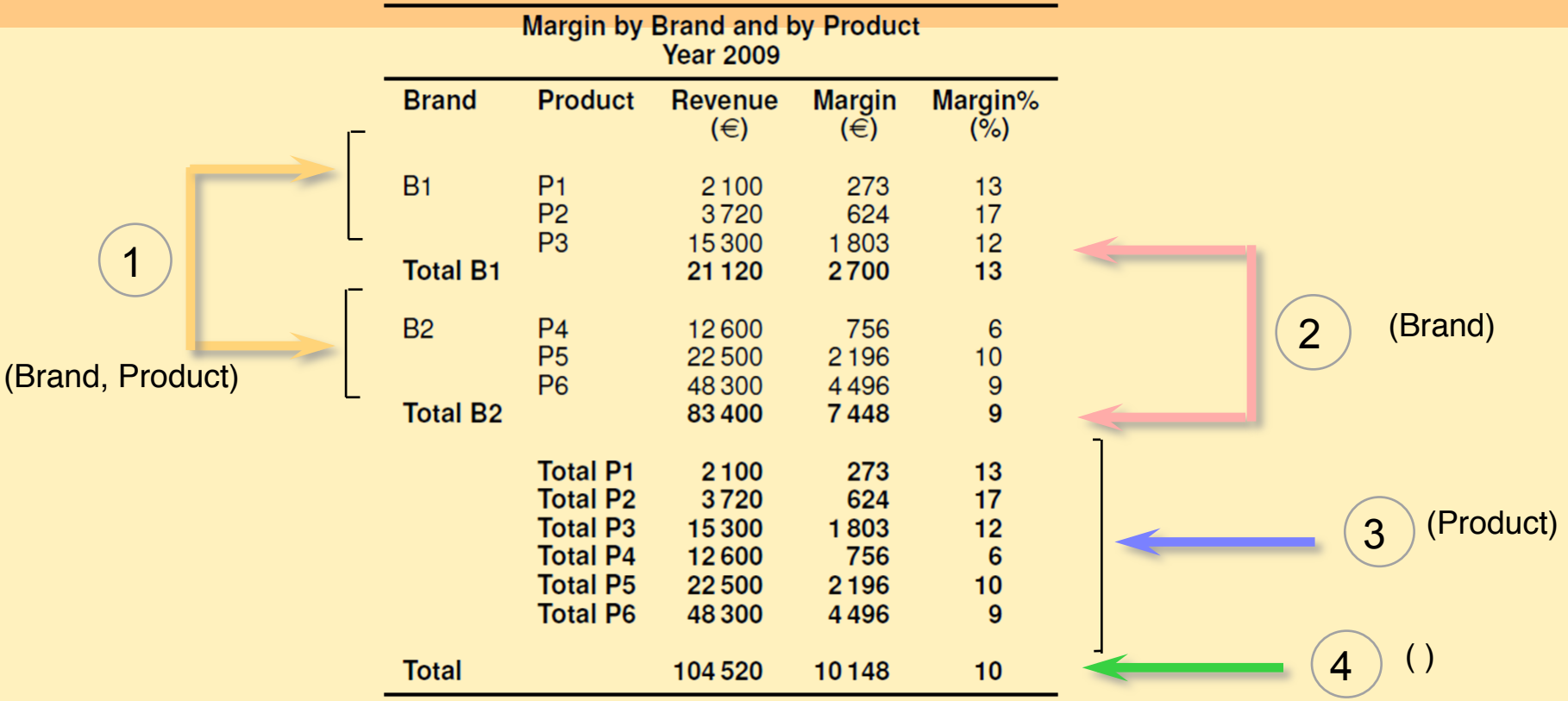
Semantics: Union of 4 groupings:

(A,B)
(A) subtotals
(B) subtotals
() totals

**CUBE** compute a sub-lattice



# SIMPLE REPORTS WITH SUBTOTALS: CUBE




Margin by Brand and by Product
Year 2009

| Brand | Product | Revenue (€) | Margin (€) | Margin% (%) |
|---|---|---|---|---|
| B1 | P1 | 2 100 | 273 | 13 |
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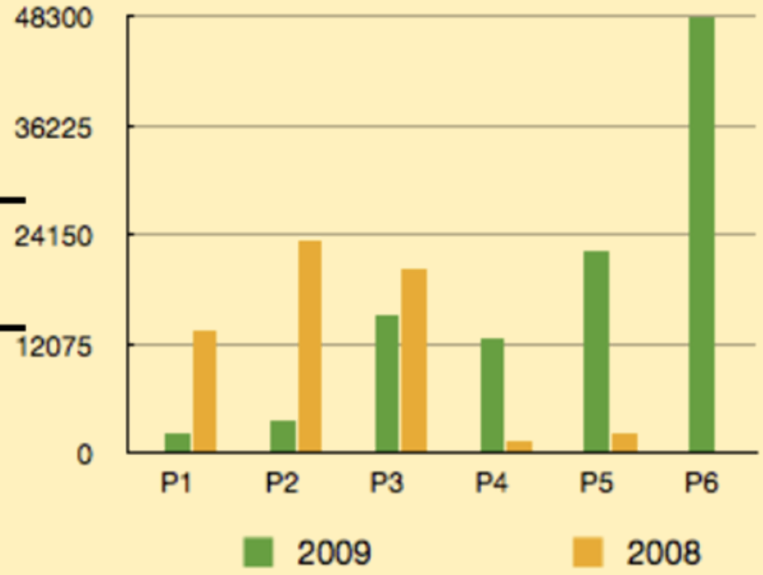
| | **Total P4** | **12 600** | **756** | **6** |
| | **Total P5** | **22 500** | **2 196** | **10** |
| | **Total P6** | **48 300** | **4 496** | **9** |
| **Total** | | **104 520** | **10 148** | **10** |

```
SELECT    Brand, Product, SUM(Revenue) AS Revenue,
          SUM(Margin) AS Margin,
          ROUND(100*SUM(Margin)/SUM(Revenue)) AS Margin%
FROM      Sales
WHERE     YEAR(Date) = 2009
GROUP BY  CUBE (Brand, Product)
ORDER BY  Brand, Product;
```

# MODERATELY DIFFICULT REPORTS WITH COMPARISON BETWEEN COLUMNS (VARIANCE REPORT)

| Comparison between Revenue by Brand and by Product 2009 – 2008 | | | | |
|---|---|---|---|---|
| Brand | Product | Revenue (€) 2009 | Revenue (€) 2008 | Delta (%) |
| B1 | P1 | 2 100 | 13 560 | −546 |
| | P2 | 3 720 | 23 640 | −535 |
| | P3 | 15 300 | 20 340 | −33 |
| B2 | P4 | 12 600 | 1 440 | 89 |
| | P5 | 22 500 | 2 100 | 91 |
| | P6 | 48 300 | | 100 |




**Delta = 100 x (Revenue2009 - Revenue2008)/Revenue2009**

**A product may have been sold in one year, but not in the other !**

# JOIN

**R**

| A | B |
|---|---|
| 1 | a |
| 2 | b |

**S**

| A | C |
|---|---|
| 1 | x |
| 2 | y |

```
SELECT *
FROM R
NATURAL JOIN
S;
```

| A | B | C |
|---|---|---|
| 1 | a | x |
| 2 | b | y |

**R**

| A | B |
|---|---|
| 1 | a |
| 2 | b |
| 3 | c |

**S**

| A | C |
|---|---|
| 1 | x |
| 3 | y |
| 5 | z |

```
SELECT *
FROM R
NATURAL JOIN
S;
```

| A | B | C |
|---|---|---|
| 1 | a | x |
| 3 | c | y |

# JOIN

**R**

| A | B |
|---|---|
| 1 | a |
| 2 | b |
| 3 | c |

**S**

| A | C |
|---|---|
| 1 | x |
| 3 | y |
| 5 | z |

```
SELECT *
FROM   R
       NATURAL FULL JOIN
       S;
```

| A | B | C |
|---|---|---|
| 1 | a | x |
| 2 | b | |
| 3 | c | y |
| 5 | | z |

```
SELECT *
FROM   R
       FULL JOIN
       S USING (A);
```

# SOLUTION USING VIEWS

| Comparison between Revenue by Brand and by Product 2009 – 2008 | | | | |
|---|---|---|---|---|
| Brand | Product | Revenue (€) 2009 | Revenue (€) 2008 | Delta (%) |
| B1 | P1 | 2 100 | 13 560 | −546 |
| | P2 | 3 720 | 23 640 | −535 |
| | P3 | 15 300 | 20 340 | −33 |
| B2 | P4 | 12 600 | 1 440 | 89 |
| | P5 | 22 500 | 2 100 | 91 |
| | P6 | 48 300 | | 100 |

```
CREATE VIEW VRevenue09 AS
SELECT    Brand, Product, SUM(Revenue) AS Revenue2009
FROM      Sales      WHERE Year(Data) = 2009
GROUP BY  Brand, Product;

CREATE VIEW VRevenue08 AS
SELECT    Brand, Product, SUM(Revenue) AS Revenue2008
FROM      Sales      WHERE Year(Data) = 2008
GROUP BY  Brand, Product;
```

```
SELECT    VRevenue09.Brand AS Brand,  VRevenue09.Product AS Product, Revenue2009, Revenue2008,
          CASE
             WHEN Revenue2009 IS NULL THEN -100
             WHEN Revenue2008 IS NULL THEN 100
             ELSE  ROUND(100*(Revenue2009 - Revenue2008)/Revenue2009)  END AS   Delta
FROM      VRevenue09 FULL JOIN VRevenue08 USING(Brand, Product)
ORDER BY  Brand, Product
```

# SOLUTION USING 'WITH' CLAUSE

```
WITH    Revenue09 AS
        ( SELECT    Brand, Product, SUM(Revenue) AS Revenue2009
          FROM      Sales
          WHERE     YEAR(Date) = 2009
          GROUP BY  Brand, Product
        )
        , Revenue08 AS
        ( SELECT    Brand, Product, SUM(Revenue) AS Revenue2008
          FROM      Sales
          WHERE     YEAR(Date) = 2008
          GROUP BY  Brand, Product
        )

SELECT  Revenue09.Brand AS Brand, Revenue09.Product AS Product
        , Revenue2009
        , Revenue2008
        , CASE
          WHEN Revenue2009 IS NULL THEN -100
          WHEN Revenue2008 IS NULL THEN 100
          ELSE ROUND(100*(Revenue2009 - Revenue2008)/Revenue2009)
        END AS Delta
FROM    Revenue09 FULL JOIN Revenue08 USING (Brand, Product)
ORDER BY Brand, Product;
```

# EXERCISE: MODERATELY DIFFICULT REPORTS WITH COMPARISON ACROSS AGGREGATION LEVELS

**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)

**Revenue by Brand and Product**
**January 2008**

| Brand | Product | Revenue (€) | Percent of Brand Revenue | Percent of Total Revenue |
|---|---|---|---|---|
| M1 | P1 | 175,000 | 45% | 21% |
| | P2 | 96,000 | 25% | 12% |
| | P3 | 114,000 | 30% | 14% |
| **M1** | **All products** | **385,000** | **100%** | **47%** |
| M2 | P4 | 102,400 | 23% | 12% |
| | P5 | 96,200 | 22% | 12% |
| | P6 | 124,000 | 28% | 15% |
| | P7 | 120,000 | 27% | 14% |
| **M2** | **All products** | **442,600** | 100% | **53%** |
| **All brands** | | **827,000** | | **100%** |

# VERY DIFFICULT REPORTS WITHOUT ANALYTIC SQL: RUNNING TOTALS

**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)

**Product P1 Revenue by Quarter and Month**
**Year 2009**

| Quarter | Month | Revenue (€) | Revenue QtoD (€) | Revenue YtoD (€) |
|---|---|---|---|---|
| Q1 | January | 16 500 | 16 500 | 16 500 |
| Q1 | February | 14 220 | 30 720 | 30 720 |
| Q1 | March | 27 480 | 58 200 | 58 200 |
| Q2 | April | 7 920 | 7 920 | 66 120 |
| Q2 | May | 1 200 | 9 120 | 67 320 |
| Q2 | June | 1 260 | 10 380 | 68 580 |
| Q3 | July | 5 400 | 5 400 | 73 980 |
| Q3 | August | 11 730 | 17 130 | 85 710 |
| Q3 | September | 10 860 | 27 990 | 96 570 |
| Q4 | October | 5 850 | 5 850 | 102 420 |
| Q4 | November | 2 100 | 7 950 | 104 520 |
| Q4 | December | | | |

# VERY DIFFICULT REPORTS WITHOUT ANALYTIC SQL: RANK

**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)

Revenues and Ranks in the 2009 by Region and by Product

| Region | Product | Total Revenue | Product Rank by Region | Product Rank Global |
|---|---|---|---|---|
| Lazio | P3 | 2880 | 3 | 4 |
| | P2 | 960 | 5 | 8 |
| | P4 | 2 700 | 4 | 5 |
| | P1 | 480 | 6 | 10 |
| | P5 | 4 800 | 2 | 2 |
| | P6 | 11 400 | 1 | 1 |
| Toscana | P1 | 120 | 6 | 12 |
| | P6 | 3 600 | 1 | 3 |
| | P3 | 1 800 | 2 | 6 |
| | P5 | 1 500 | 3 | 7 |
| | P4 | 900 | 4 | 9 |
| | P2 | 240 | 5 | 11 |

Which are the **best 5** products sold in Toscana?

# VERY DIFFICULT REPORTS WITHOUT ANALYTIC SQL

**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)

We want to partition the customers into four groups:

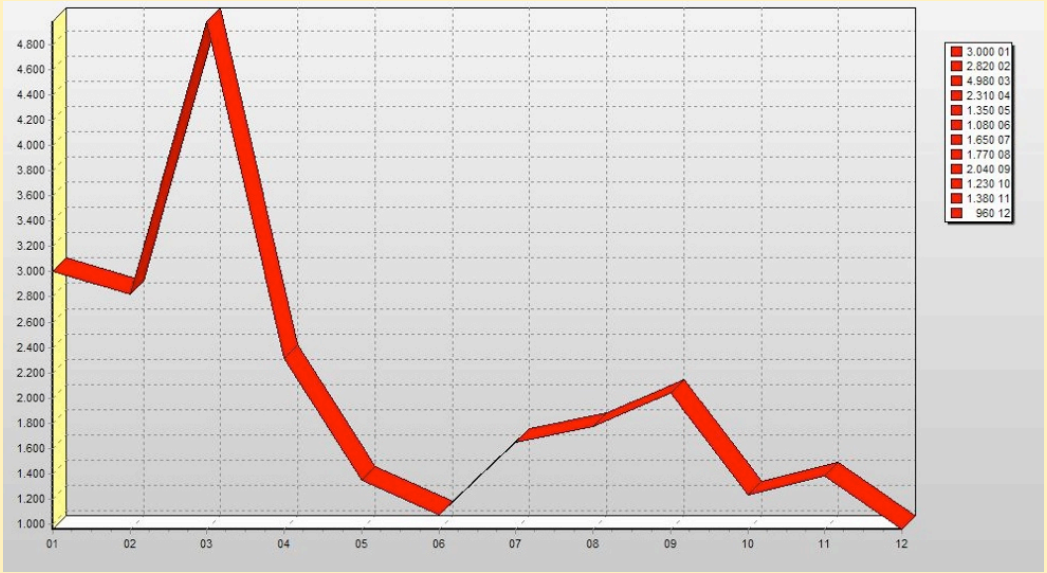
- **Top5%**, with 5% of customers with the highest amount of revenues.
- **Next15%**, with 15% of other customers with the highest amount of revenues.
- **Middle30%**, with 30% of other customers with the highest amount of revenues.
- **Bottom50%**, with 50 % of the customers with the lowest amount of revenues.

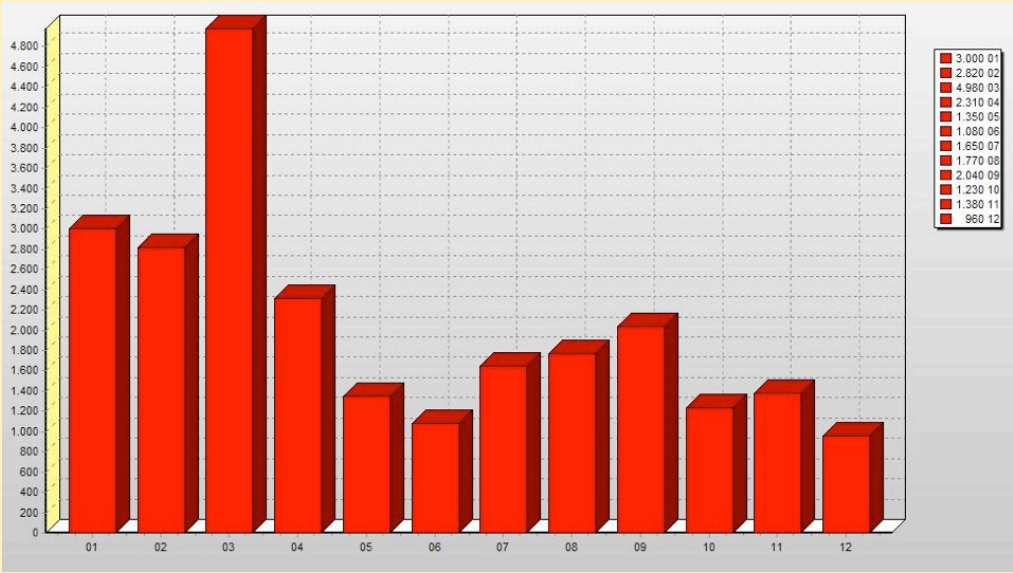
For each customer group we want to know their number, and the percentage of the sum of their revenues compared to total revenue of all sales.

| Group | Number of customers | Percent of total revenue |
|---|---|---|
| Top5% | 1 | 20 |
| Next15% | 3 | 50 |
| Middle30% | 6 | 20 |
| Bottom50% | 10 | 10 |

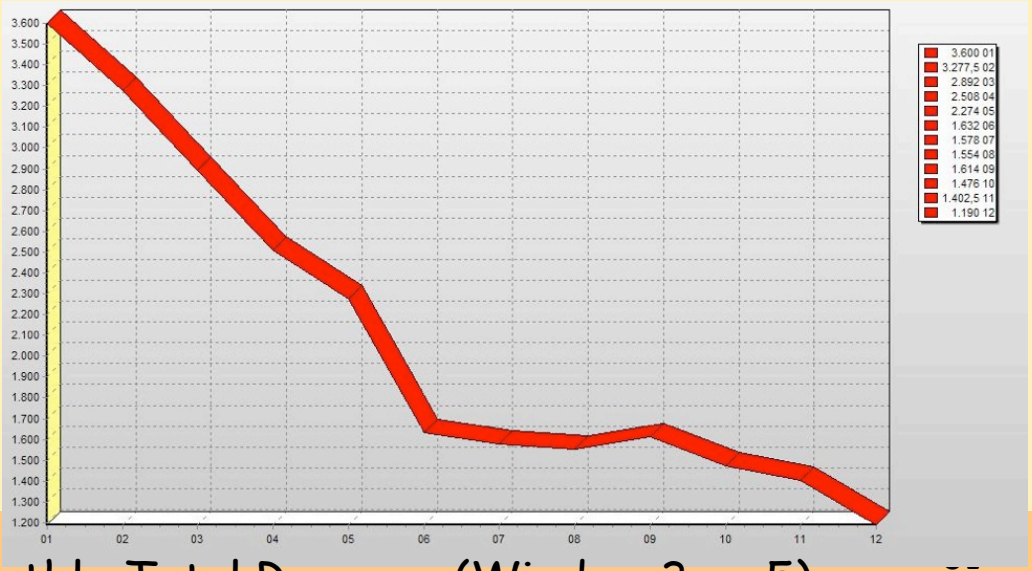
# VERY DIFFICULT REPORTS WITHOUT ANALYTIC SQL

**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)




Monthly Total Revenue


Moving Average Monthly Total Revenue (Window 3 or 5)

## Syntax

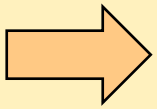
**SELECT** Select Attributes ($S_A$), Select Aggregation Functions ($S_{AF}$),

**FROM** Fact table (F) and a dimension table (D1)
**WHERE** Where condition ($W_C$)
**GROUP BY** Grouping Attributes ($G_A$)
**HAVING** Having condition ($H_C$) with aggregation functions ($H_{AF}$)
**ORDER BY** Sorting attributes ($O_A$);

# Intuition: Partition By

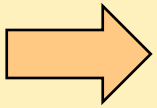
| R | |
|---|---|
| P | ... |
| P1 | ... |
| P1 | ... |
| P2 | ... |
| P2 | ... |
| P2 | ... |
| P2 | ... |
| P2 | ... |

```
SELECT    P, COUNT(*) AS No
FROM      R
GROUP BY  P;
```



| P | No |
|---|---|
| P1 | 2 |
| P2 | 5 |

```
SELECT    P,
          COUNT(*) OVER (PARTITION BY  P) AS No
FROM      R
ORDER BY  P;
```

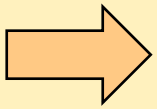


| P | No |
|---|---|
| P1 | 2 |
| P1 | 2 |
| P2 | 5 |
| P2 | 5 |
| P2 | 5 |
| P2 | 5 |
| P2 | 5 |

# Intuition: without Partition By

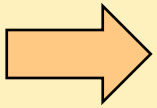
| R | |
|---|---|
| P | ... |
| P1 | ... |
| P1 | ... |
| P2 | ... |
| P2 | ... |
| P2 | ... |
| P2 | ... |
| P2 | ... |

```
SELECT    COUNT(*) AS No
FROM      R
```



| No |
|---|
| 7 |

```
SELECT    P, COUNT(*) OVER( ) AS No
FROM      R
ORDER BY  P;
```



| P | No |
|---|---|
| P1 | 7 |
| P1 | 7 |
| P2 | 7 |
| P2 | 7 |
| P2 | 7 |
| P2 | 7 |
| P2 | 7 |

## Execution order

**ORDER BY** $O_A$

**SELECT** $S_A$, $S_{AF}$,

$A_F$ **OVER (...)**

**HAVING** $H_C$

**GROUP BY** $G_A$

**WHERE** $W_C$

**FROM** F, D1

| | |
|---|---|
| **SELECT** | Select Attributes ($S_A$), Select Aggregation Functions ($S_{AF}$), Analytic Function ($A_F$) **OVER(** [**PARTITION BY** <attribute list>] [**ORDER BY** <sort attribute list> [<window clause>]]) |
| **FROM** | Fact table (F) and a dimension table (D1) |
| **WHERE** | Where condition ($W_C$) |
| **GROUP BY** | Grouping Attributes ($G_A$) |
| **HAVING** | Having condition ($H_C$) with aggregation functions ($H_{AF}$) |
| **ORDER BY** | Sorting attributes ($O_A$); |

# RANK

```
SELECT Customer, Product, SUM(Revenue) AS TotalRev,
       RANK ( ) OVER (ORDER BY SUM(Revenue) ) AS Rank
FROM Sales WHERE Customer IN ('C1', 'C2')
GROUP BY Customer, Product  ORDER BY TotalRev DESC;
```

| Customer | Product | TotalRev | Rank |
|---|---|---|---|
| C1 | P1 | 1100 | 7 |
| C1 | P3 | 1000 | 6 |
| C2 | P1 | 1000 | 5 |
| C2 | P2 | 900 | 4 |
| C2 | P4 | 800 | 3 |
| C1 | P2 | 200 | 2 |
| C2 | P3 | 200 | 1 |

# RANK WITH PARTITIONS

```
SELECT Customer, Product, SUM(Revenue) AS TotalRevenue,
       RANK ( ) OVER (PARTITION BY Customer
          ORDER BY SUM(Revenue) DESC) AS Rank
FROM Sales WHERE Customer IN ('C1', 'C2')
GROUP BY Customer, Product;
```

| Customer | Product | TotalRev | Rank |
|---|---|---|---|
| C1 | P1 | 1100 | 1 |
| C1 | P3 | 1000 | 2 |
| C1 | P2 | 200 | 3 |
| C2 | P1 | 1000 | 1 |
| C2 | P2 | 900 | 2 |
| C2 | P4 | 800 | 3 |
| C2 | P3 | 200 | 4 |

# RANK vs DENSE_RANK vs ROW_NUMBER

```
<RankFunction>()
OVER(
      [PARTITION BY <attribute list>]
       ORDER BY <sort attribute list>
) [ AS Ide ]
```

- Consider the values in the ascending order
  - (10; 20; 20; 30; 30; 40)
- RANK() of a value is 1 + the number of values that strictly precedes it
  - ranks (1; 2; 2; 4; 4; 6)
- DENSE_RANK() of a value is 1 + the number of distinct values that precedes it
  - dense ranks (1; 2; 2; 3; 3; 4)
- PERCENT_RANK() is (RANK() – 1) / (TotalRows – 1)
  - percent ranks (0; 0.2; 0.2; 0.6; 0.6; 1)
- ROW_NUMBER() is the row number
  - row numbers (1; 2; 3; 4; 5; 6)
- CUME_DIST() is ROW_NUMBER() / TotalRows
  - cumulative distribution (0.16; 0.33; 0.5; 0.67; 0.83; 1)
- NTILE(3) is the tertile of the value (3 is a parameter, can be any integer)
  - tertiles (1; 1; 2; 2; 3; 3)

# OTHER ANALYTIC FUNCTIONS

- COUNT(), SUM(), AVG(), MIN(), MAX() … and all standard aggregates

Sales(Brand, Product, Revenue)

| Brand | Product | prodRevenue | PctOverBrand | PctOverTot |
|---|---|---|---|---|
| B1 | P1 | 40 | 40 | 20 |
| B1 | P2 | 60 | 60 | 30 |
| B2 | P3 | 20 | 20 | 10 |
| B2 | P4 | 80 | 80 | 40 |

```
WITH s AS (SELECT Brand, Product,SUM(Revenue) AS prodRevenue
FROM sales
GROUP BY Brand, Product)
SELECT Brand, Product, prodRevenue,
   100 * prodRevenue / SUM(prodRevenue) OVER(PARTITION BY Brand) AS PctOverBrand,
   100 * prodRevenue / SUM(prodRevenue) OVER() AS PctOverTot
FROM s

SELECT Brand, Product, SUM(Revenue) AS prodRevenue,
   100 * SUM(Revenue) / SUM(SUM(Revenue)) OVER(PARTITION BY Brand) AS PctOverBrand,
   100 * SUM(Revenue) / SUM(SUM(Revenue)) OVER() AS PctOverTot
FROM sales
GROUP BY Brand, Product
```

# OTHER ANALYTIC FUNCTIONS

- LAG(attribute, offset, default) and LEAD(attribute, offset, default)
  - The value of attribute in offset rows before (LAG) or after (LEAD)

```
SELECT Store, Year, TotalRev,
  LEAD(TotalRev, 1, 0) OVER(PARTITION BY Store ORDER BY Year DESC) AS PrevRev,
FROM TotalSales
ORDER BY Store, Year
```

| Store | Year | TotalRev | PrevRev |
|---|---|---|---|
| S1 | 2015 | 1100 | 1000 |
| S1 | 2014 | 1000 | 200 |
| S1 | 2013 | 200 | 0 |
| S2 | 2015 | 1000 | 900 |
| S2 | 2014 | 900 | 800 |
| S2 | 2013 | 800 | 200 |
| S2 | 2012 | 200 | 0 |

# WINDOWING

```
<AggregateFunction>(<expr>)
OVER(
      [PARTITION BY <attribute list>]
      [ORDER BY <sort attribute list>
       [<ROWS or RANGE> <window size specification>]]
     ) [ AS Ide ]
```

Windowing functions are used to compute cumulative, moving and centered aggregates.

Window functions add a value to each row that depends on the other rows in the window.

Examples of window specifications:

**ROWS UNBOUNDED PRECEDING.** The window begin with the first record of the partition and ends with the current record.

**ROWS BETWEEN ... PRECEDING AND ... FOLLOWING.** The window include all records that fall within the given offset.

# WINDOWING EXAMPLE

**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)

**Product P1 Revenue by Quarter and Month**
**Year 2009**

| Quarter | Month | Revenue (€) | Revenue QtoD (€) | Revenue YtoD (€) |
|---|---|---|---|---|
| Q1 | January | 16 500 | 16 500 | 16 500 |
| Q1 | February | 14 220 | 30 720 | 30 720 |
| Q1 | March | 27 480 | 58 200 | 58 200 |
| Q2 | April | 7 920 | 7 920 | 66 120 |
| Q2 | May | 1 200 | 9 120 | 67 320 |
| Q2 | June | 1 260 | 10 380 | 68 580 |
| Q3 | July | 5 400 | 5 400 | 73 980 |
| Q3 | August | 11 730 | 17 130 | 85 710 |
| Q3 | September | 10 860 | 27 990 | 96 570 |
| Q4 | October | 5 850 | 5 850 | 102 420 |
| Q4 | November | 2 100 | 7 950 | 104 520 |
| Q4 | December | | | |

# WINDOWING EXAMPLE

**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)

| Product P1 Revenue by Quarter and Month Year 2009 | | | | |
|---|---|---|---|---|
| **Quarter** | **Month** | **Revenue (€)** | **Revenue QtoD (€)** | **Revenue YtoD (€)** |
| Q1 | January | 16 500 | 16 500 | 16 500 |
| Q1 | February | 14 220 | 30 720 | 30 720 |
| Q1 | March | 27 480 | 58 200 | 58 200 |
| Q2 | April | 7 920 | 7 920 | 66 120 |
| Q2 | May | 1 200 | 9 120 | 67 320 |
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| Q4 | October | 5 850 | 5 850 | 102 420 |
| Q4 | November | 2 100 | 7 950 | 104 520 |
| Q4 | December | | | |

# EXAMPLE

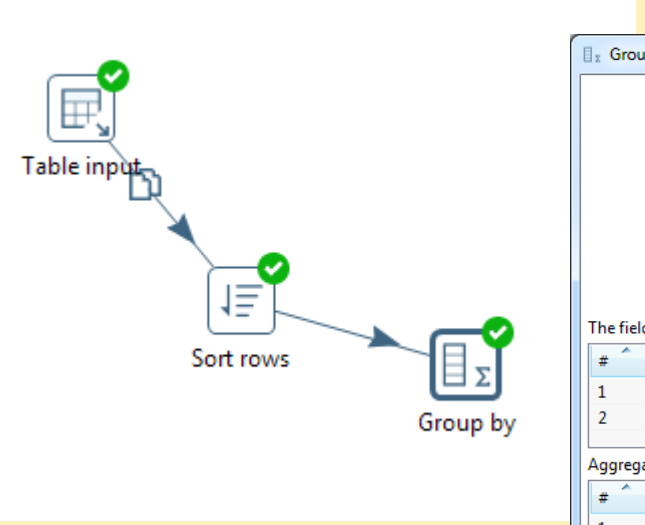
**Sales**(Customer, Product, Brand, Date, City, Region, Area, Quantity, Revenue, Margin)

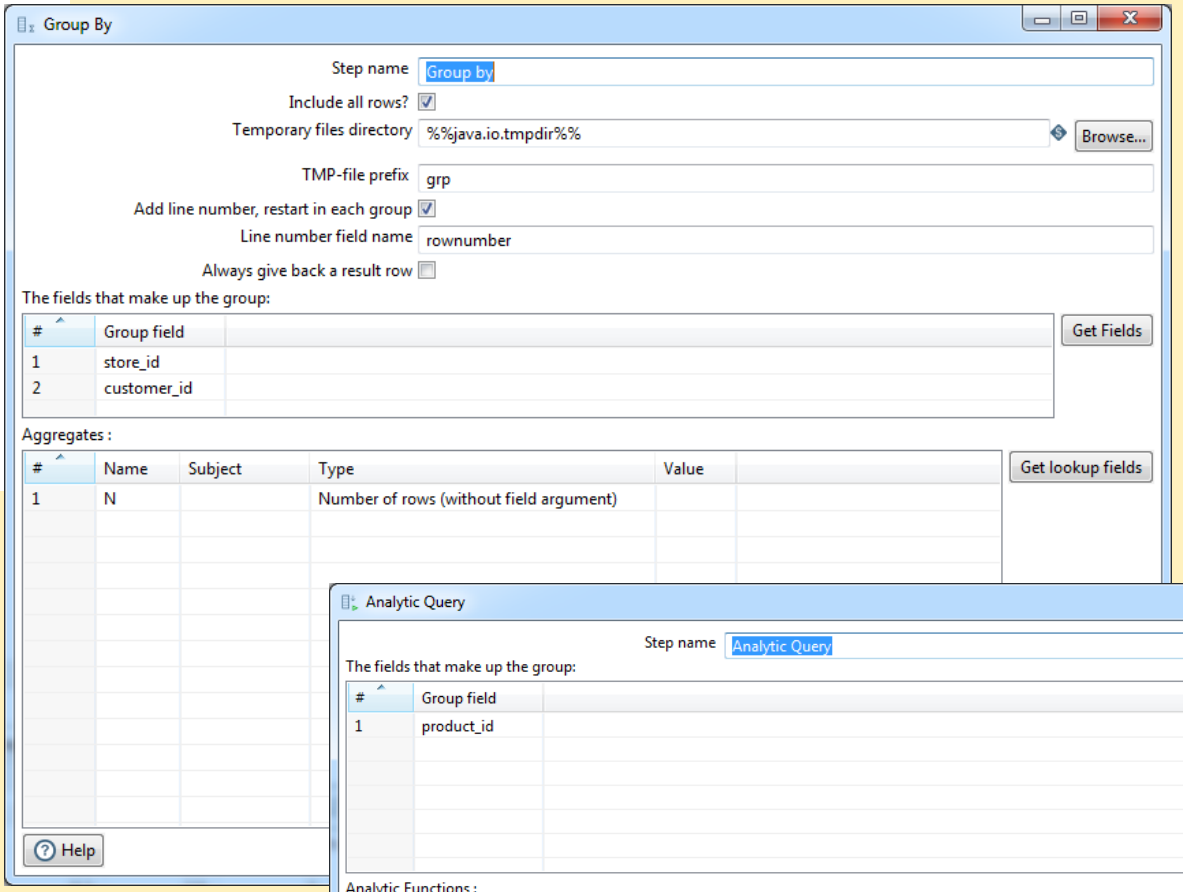
A moving average of total revenue, with a moving window of 3 months, by month.

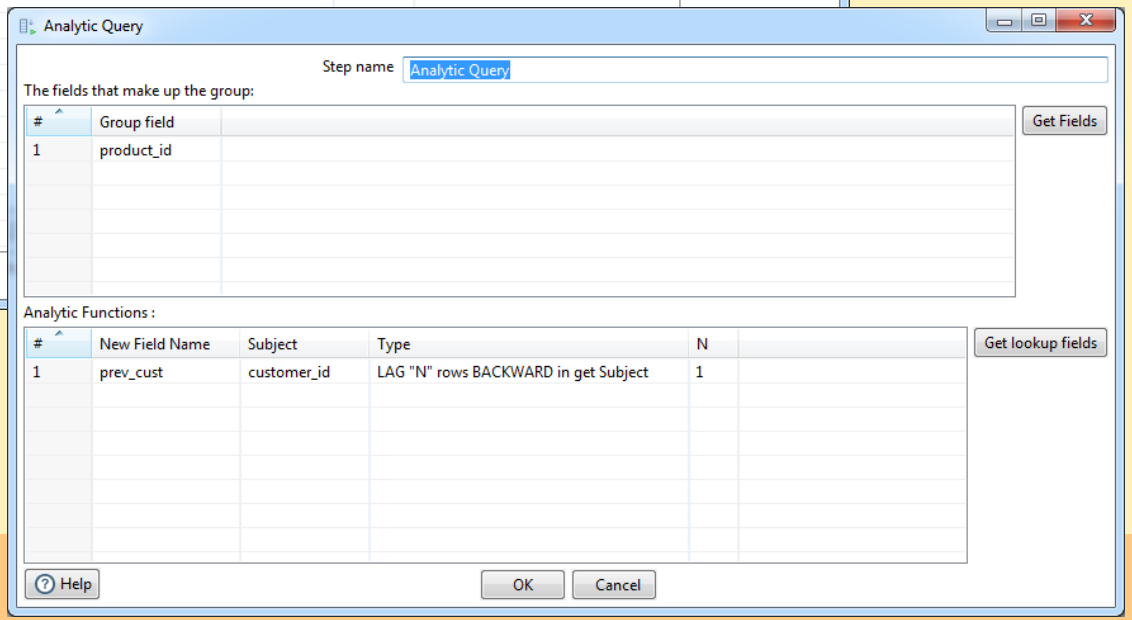
```
SELECT      MONTH(Date) AS Month

FROM        Sales
GROUP BY    MONTH(Date)
ORDER BY    Month;
```

Result visualization in Oracle...

# ANALYTIC FUNCTIONS IN PENTAHO DATA INTEGRATION

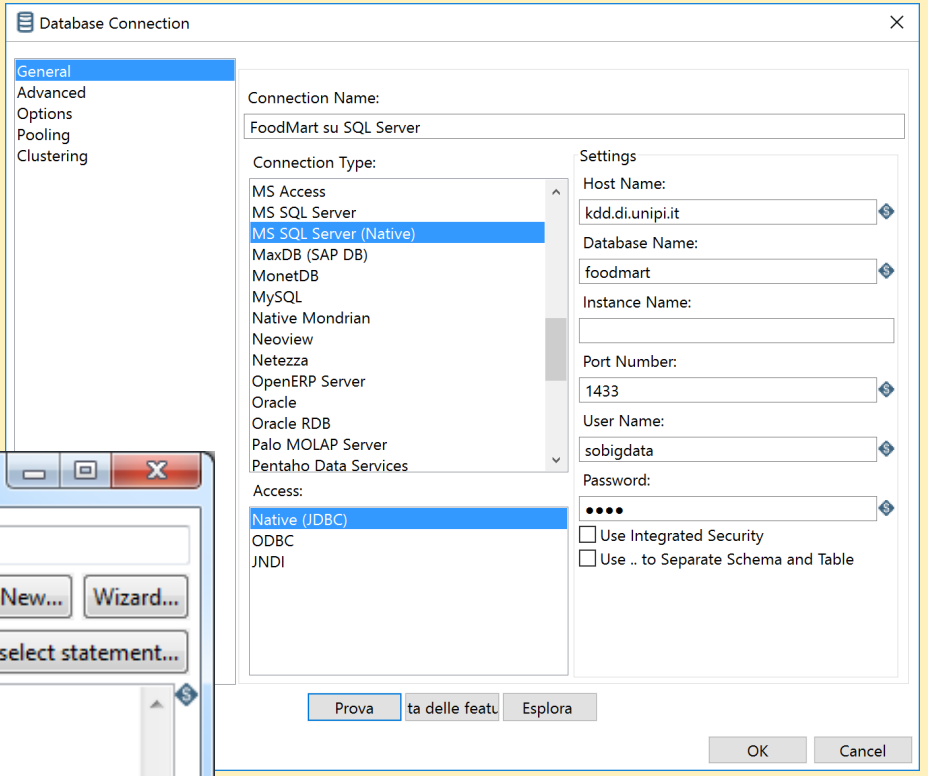


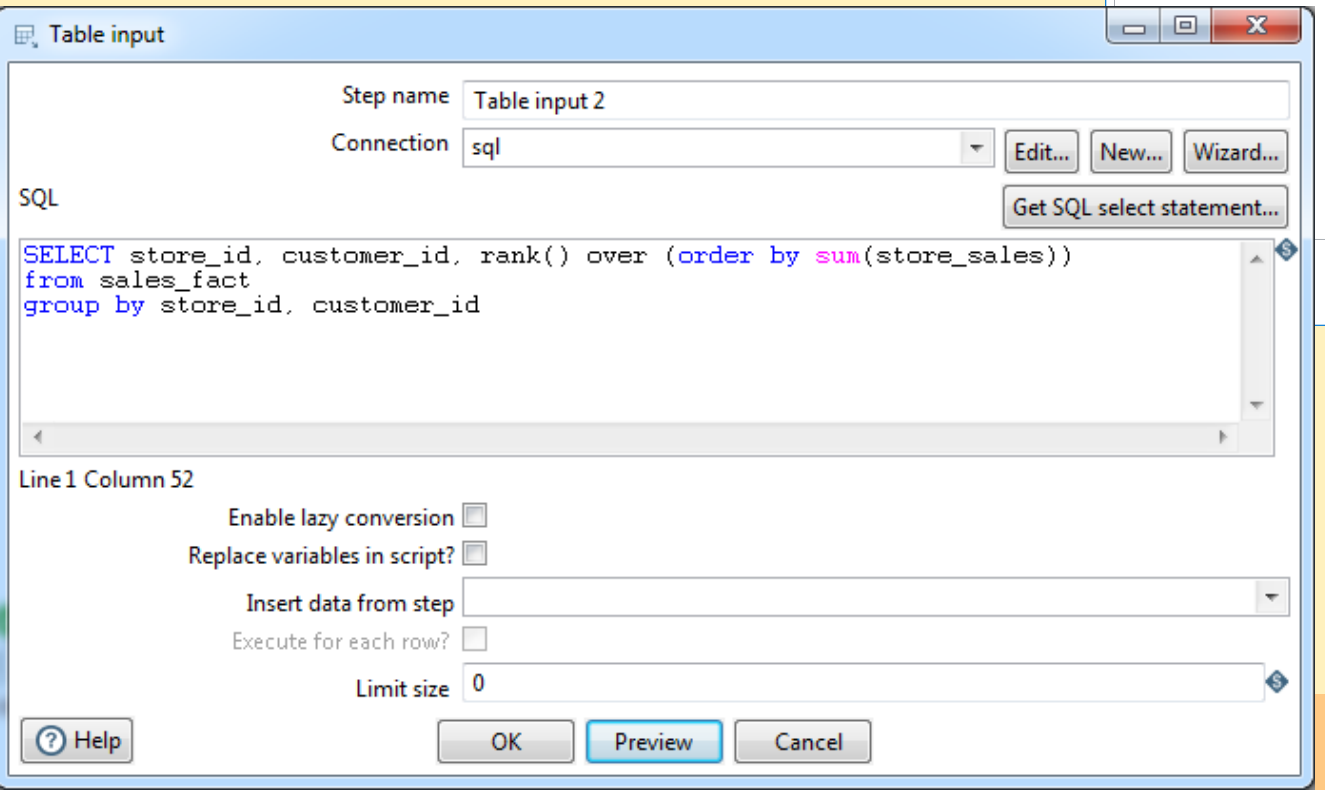




Cube, A. Albano

# OR CONNECT TO SQL SERVER 2014 ON KDD.DI.UNIPI.IT
# LOGIN: sobigdata  PWD: pisa



# SUMMARY

SQL is not select-from-where **only**.

**Grouping** and **aggregation** is a major part of SQL.

SQL has been extended for OLAP operations, because of intensive data warehouse applications during the last decade.

**Make sure you understand SQL. It is much more than syntax.**