a brand of Loader

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ADVANCED DAX WORKSHOP

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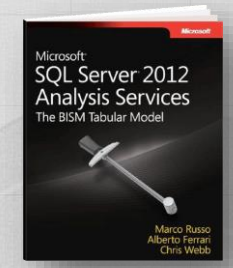
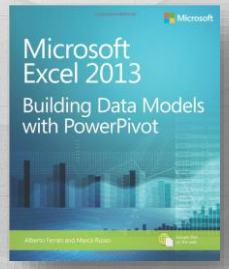
Alberto Ferrari
alberto.ferrari@sqlbi.com
twitter @FerrariAlberto

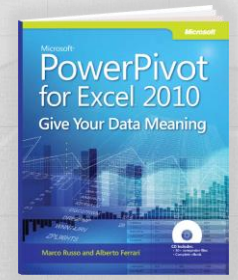
Many-to-many in DAX

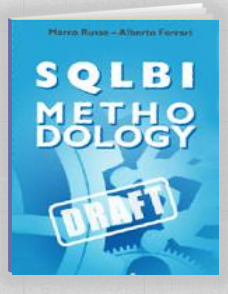
Who We Are

- BI Experts and Consultants
- Founders of www.sqlbi.com
  - Problem Solving
  - Complex Project Assistance
  - DataWarehouse Assesments and Development
  - Courses, Trainings and Workshops
- Book Writers
- Microsoft Gold Business Intelligence Partners
- SSAS Maestros – MVP – MCP

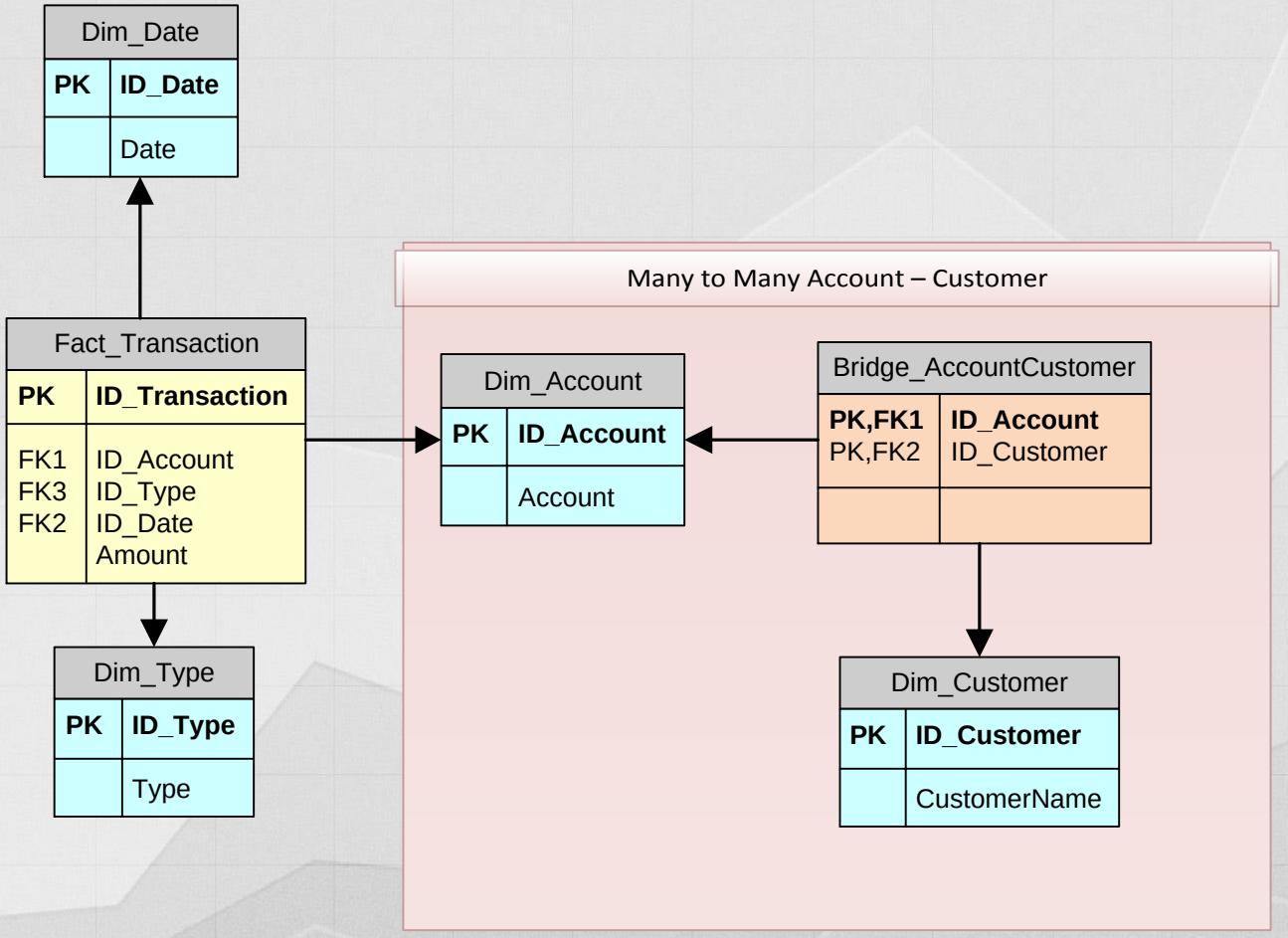








Many-to-many Relationships



No support for M2M in Tabular

- Multidimensional handles M2M
  - Directly in the engine
  - Performance may suffer
- Tabular does not handle M2M
  - Only plain vanilla 1:N relationships
  - Only on one column
  - Seems not to be enough…
- But… hey, we have DAX!

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Demo – Classical M2M

- We will start looking at the final result
- Then, we dive into the DAX code

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The M2M DAX Pattern

- Leverages
  - CALCULATE
  - Row Contexts
  - Filter Contexts
  - Automatic transformation of Row Context into Filter Context using CALCULATE
- Next slide: the formula
  - Keep it in mind
  - It will appear quite often from now on

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The DAX Formula

The pattern of many-to-many is always the same
(Later we will see an optimized version)

```
AmountM2M :=

CALCULATE(
    SUM( Fact_Transaction[Amount] ),
    FILTER(
        Dim_Account,
        CALCULATE(
            COUNTROWS( Bridge_AccountCustomer )
        ) > 0
    )
)
```

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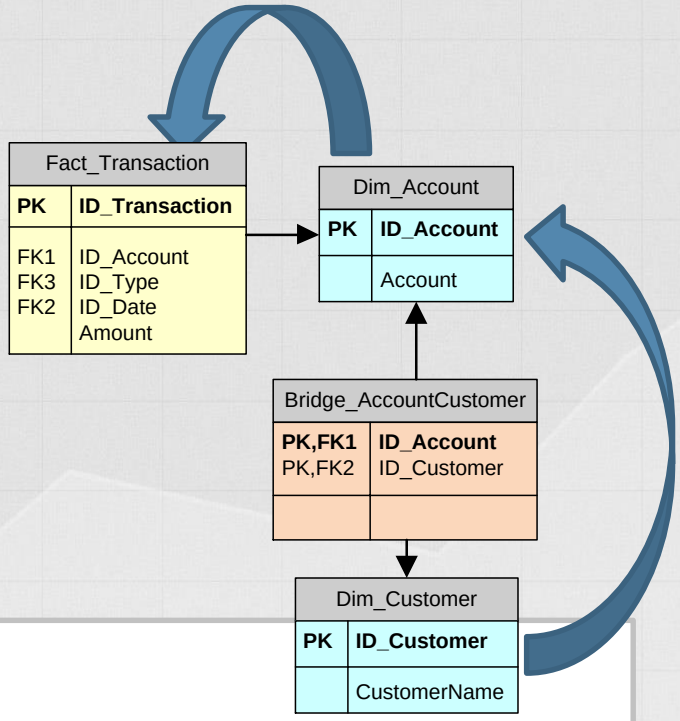
What the formula should perform



Filter on Dim_Account

Filter on Dim_Customer

```
AmountM2M :=

CALCULATE (
    SUM( Fact_Transaction[Amount] ),
    FILTER(
        Dim_Account,
        CALCULATE(
            COUNTROWS( Bridge_AccountCustomer )
        ) > 0
    )
)
```

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The Karma of CALCULATE

Row Labels	AmountM2M_Wrong	AmountM2M_Correct
Luke	**5000**	**800**
Luke	800	800
Mark	**5000**	**2800**
Mark	800	800
Mark-Paul	1000	1000
Mark-Robert	1000	1000
Paul	**5000**	**1700**
Mark-Paul	1000	1000
Paul	700	700
Robert	**5000**	**1700**
Mark-Robert	1000	1000
Robert	700	700
Grand Total	**5000**	**5000**

```
AmountM2M_Correct := CALCULATE (
    SUM (Fact_Transaction[Amount]),
    FILTER (
        Dim_Account,
        CALCULATE (
            COUNTROWS (Bridge_AccountCustomer)
        ) > 0
    )
)
```

```
AmountM2M_Wrong := CALCULATE (
    SUM (Fact_Transaction[Amount]),
    FILTER (
        Dim_Account,
        COUNTROWS (Bridge_AccountCustomer) > 0
    )
)
```

Wrong formula in action

Customer
Mark
Paul
Robert
Luke

Customer	Account
Mark	Mark
Paul	Paul
Robert	Robert
Luke	Luke
Mark	Mark-Ro
Robert	Mar
Mark	aul
Paul	ark-Paul

Account
Mark
Paul
Robert
Luke
Mark-Robert
Mark-Paul

```
AmountM2M :=

CALCULATE (
    SUM (Fact_Transaction[Amount])
    FILTER (
        Dim_Account,
        COUNTROWS (Bridge_AccountCustomer) > 0
    )
)
```

All the rows in the Account table survived the FILTER

Many-to-many in action

Customer
Mark
Paul
Robert
Luke

Customer	Account
Mark	Mark
Paul	Paul
Robert	Robert
Luke	Luke
Mark	Mark-Robert
Robert	Mark-R
Mark	
Paul	rk-Paul

Account
Mark
Paul
Robert
Luke
Mark-Robert
Mark-Paul

```
AmountM2M :=

CALCULATE (
    SUM (Fact_Transaction[Am
    FILTER (
        Dim_Account,
        CALCULATE (
            COUNTROWS (Bridge_AccountCustomer)
        ) > 0
    )
)
```

Two rows in the Account table survived the FILTER

The Karma of CALCULATE

Row Labels	AmountM2M_Wrong	AmountM2M_Correct
Luke	**5000**	**800**
Luke	800	800
Mark	**5000**	**2800**
Mark	800	800
Mark-Paul	1000	1000
Mark-Robert	1000	1000
Paul	**5000**	**1700**
Mark-Paul	1000	1000
Paul	700	700
Robert	**5000**	**1700**
Mark-Robert	1000	1000
Robert	700	700
Grand Total	**5000**	**5000**

```
AmountM2M_Correct := CALCULATE (
    SUM (Fact_Transaction[Amount]),
    FILTER (
        Dim_Account,
        CALCULATE (
            COUNTROWS (Bridge_AccountCustomer)
        ) > 0
    )
)
```

```
AmountM2M_Wrong := CALCULATE (
    SUM (Fact_Transaction[Amount]),
    FILTER (
        Dim_Account,
        COUNTROWS (Bridge_AccountCustomer) > 0
    )
)
```

DAX Formula with SUMMARIZE

The formula performs much better using SUMMARIZE instead of COUNTROWS.

SUMMARIZE returns the ID_Account that are visible in the bridge with a single step, transforming them in DimAccount column references

```
AmountM2M :=

CALCULATE(
    SUM( Fact_Transaction[Amount] ),
    SUMMARIZE(
        Bridge_AccountCustomer,
        DimAccount[ID_Account]
    )
)
```

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SUMMARIZE in action

Customer
Mark
Paul
Robert
Luke

Customer	Account
Mark	Mark
Paul	Paul
Robert	Robert
Luke	Luke
Mark	Mark-Robert
Robert	Mark-Robert
Mark	Mark-Paul
Paul	Mark-Paul

Account
Mark
Paul
Robert
Luke
Mark-Robert
Mark-Paul

```
AmountM2M :=

CALCULATE(
    SUM( Fact_Transaction[Amount] ),
    SUMMARIZE(
        Bridge_AccountCustomer,
        DimAccount[ID_Account]
    )
)
```

The context is moved in a single Vertipaq operation

Many-to-many with SUMMARIZE

- The formula is
  - Much faster, no iteration needed
  - Easier to code
  - Slightly harder to understand
- Using COUNTROWS can still be useful
  - If you want to find missing values
  - To use more complex relationships
- Both formulas are worth learning

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Direct Table Filtering

Behave and performs the same as SUMMARIZE
More compact
Somewhat harder to understand, unless you learned table filtering

```
AmountM2M :=

CALCULATE(
    SUM( Fact_Transaction[Amount] ),
    Bridge_AccountCustomer
)
```

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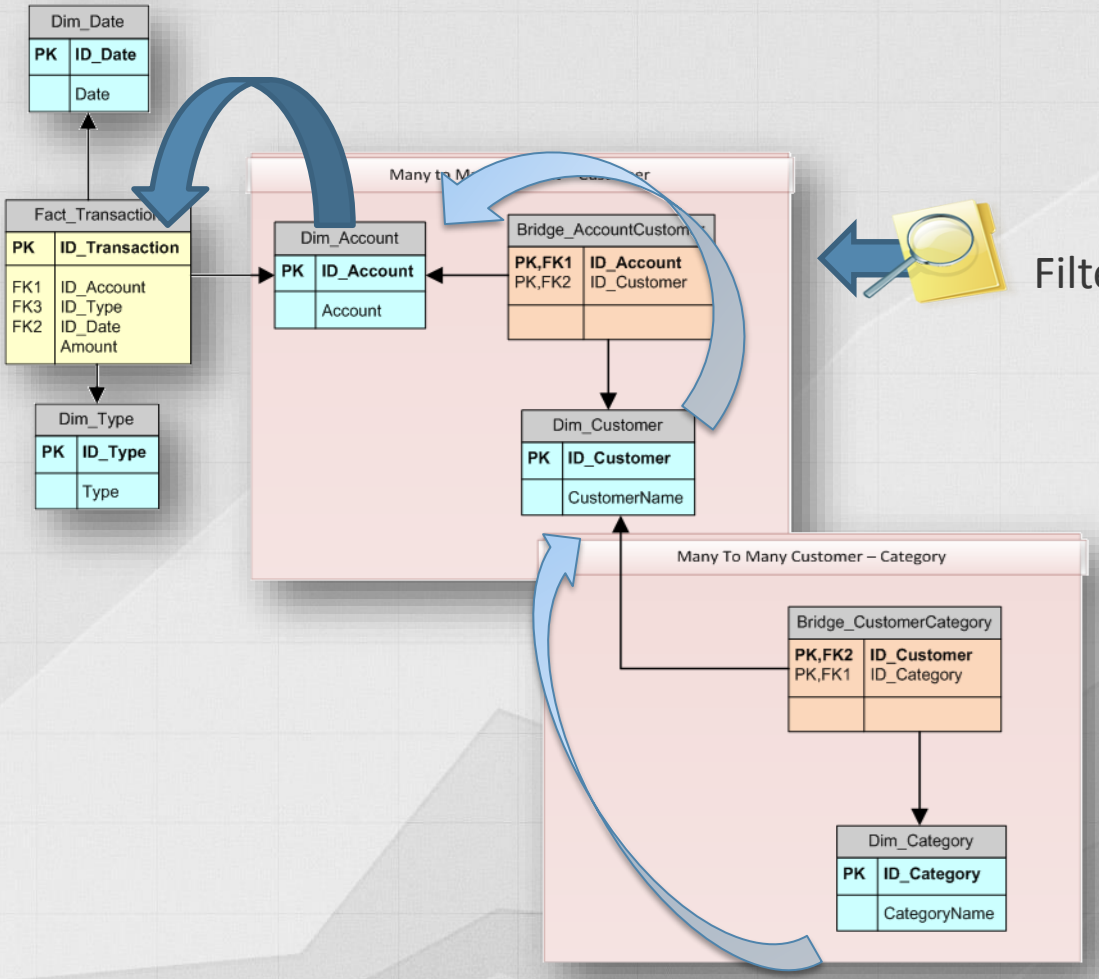
Cascading Many To Many



Filter on Dim_Account

The pattern is the same, but this time we need to jump two steps to complete our task

Filter on Dim_Category

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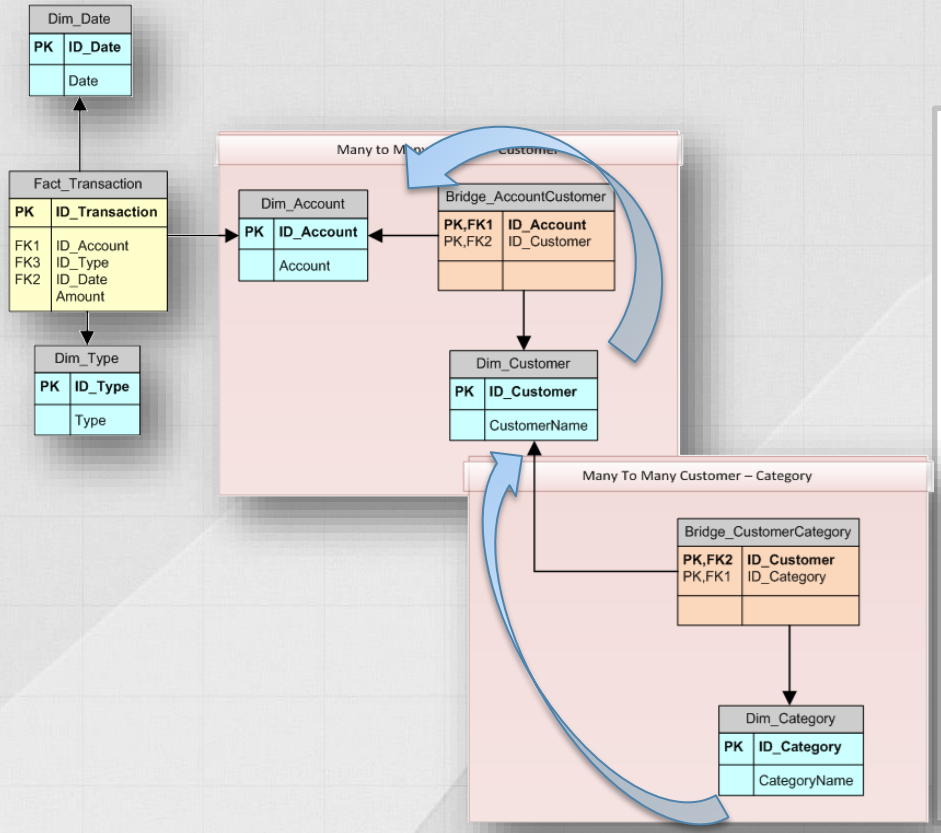
Cascading Many To Many




```
CALCULATE(
    SUM( Fact_Transaction[Amount] ),
    CALCULATETABLE (
        SUMMARIZE (
            BridgeAccountCustomer,
            DimAccount[ID_Account]
        ),
        SUMMARIZE (
            Bridge_CustomerCategory,
            DimCustomer[ID_Customer]
        )
    )
)
```

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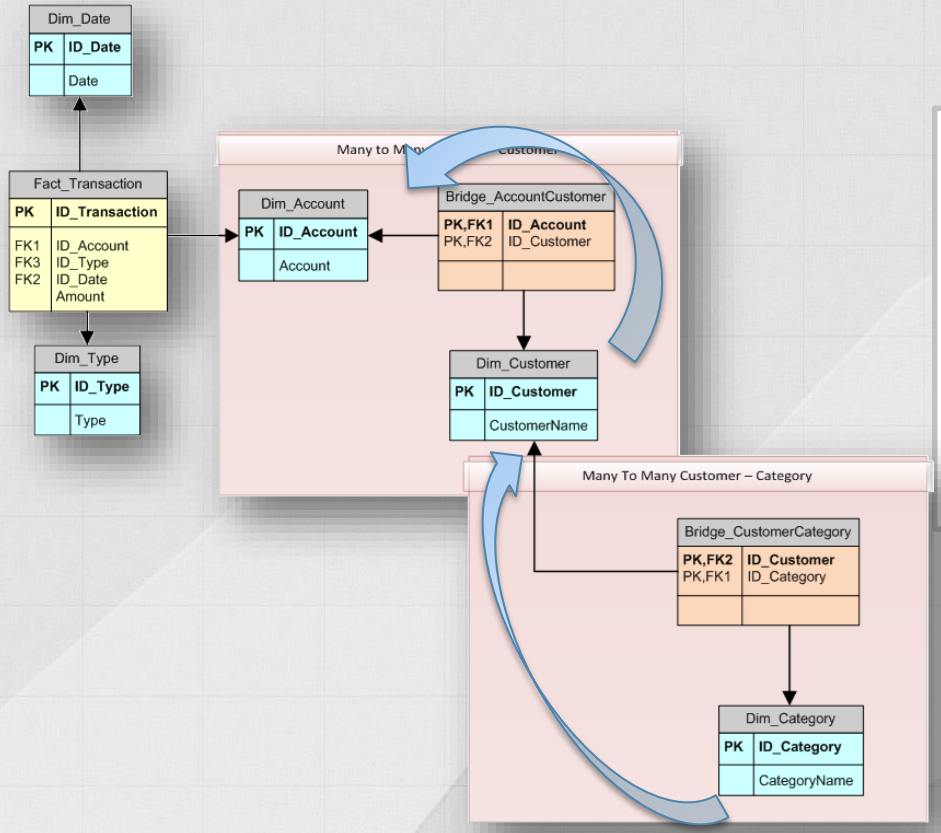
Cascading Many To Many




```
CALCULATE(
    SUM( Fact_Transaction[Amount] ),
    CALCULATETABLE (
        BridgeAccountCustomer,
        Bridge_CustomerCategory
    )
)
```

The formula is compact and fast, but not easy to read

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Cascading Many To Many

- Generic Formula
- Works with any number of steps
- Be careful
  - Start with the farthest table
  - Move one step a time towards the fact table
  - One SUMMARIZE for each step
- Complexity: M x N (geometric…)

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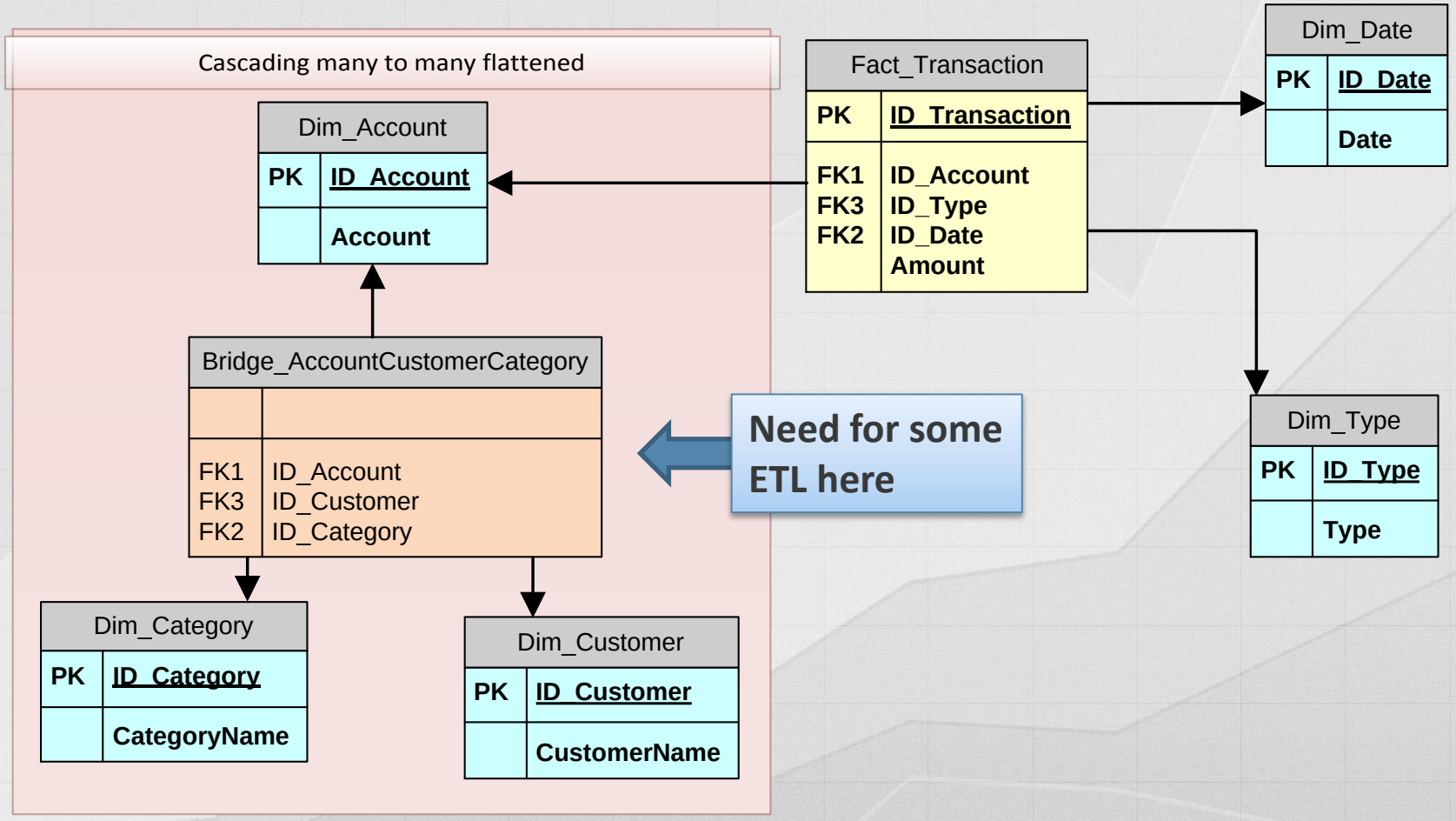
Cascading Alternative



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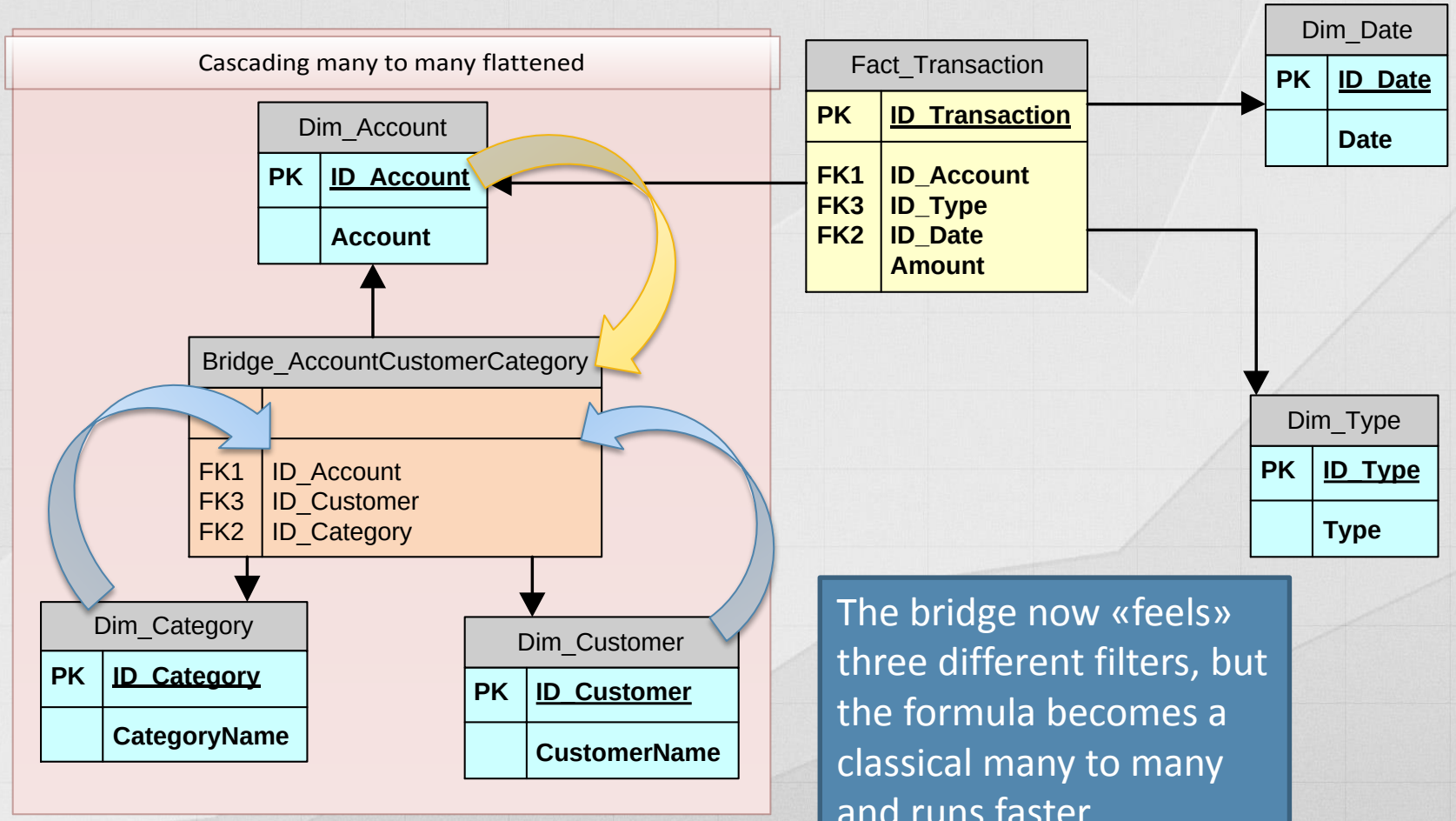
Cascading Alternative



The bridge now «feels» three different filters, but the formula becomes a classical many to many and runs faster

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Flattened Cascading Many To Many

- Flattened Data Model
- Faster than the cascading one
- Simpler formula
- Needs some ETL
  - A view is enough most of the time
- Worth a try in Multidimensional too…

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Compute the new and the returning customers is not a complex topic using the DAX language

New and Returning Customers

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New Customers

- Many useful calculations
  - Customers
  - Buying customers
  - New Customers
  - Returning customers
- Not very simple, but not «advanced»
- Once you learn the pattern
  - Sales of new customers
  - Sales of returning customers

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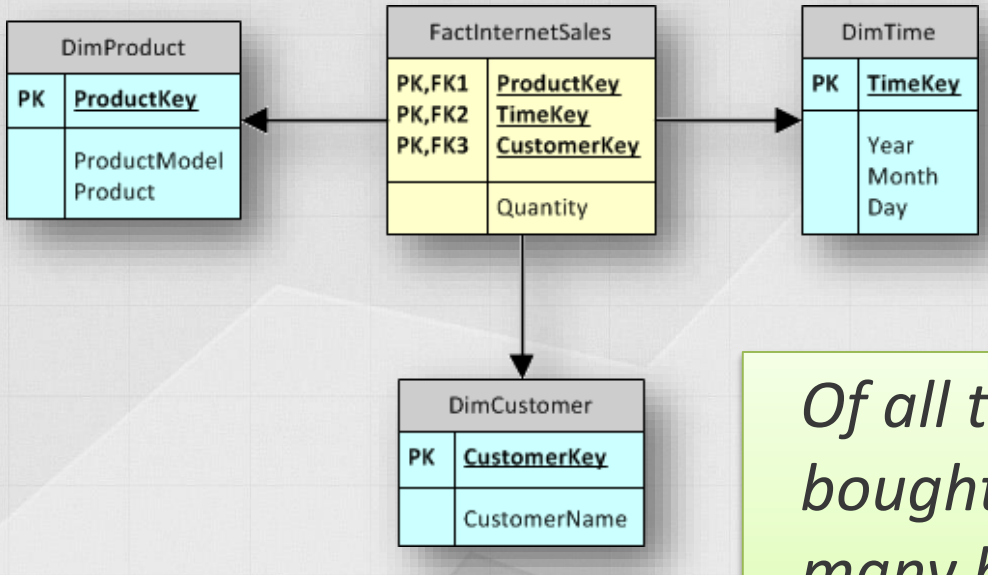
Basket analysis uses the fact table as a bridge between two dimensions

Basket Analysis

Basket Analysis: The Scenario



Of all the customers who have bought a Mountain Bike, how many have never bought a mountain tire tube?

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Basket Analysis in SQL

Two iterations over the fact table needed

```
SELECT
    COUNT (DISTINCT A.CustomerKey)
FROM
    Sales A
    INNER JOIN Sales B
        ON A.CustomerKey = B.CustomerKey
WHERE
    A.ProductModel = ‘MOUNTAIN TIRE TUBE' AND A.Year <= 2004
AND
    B.ProductModel = ‘MOUNTAIN-100' AND B.Year <= 2004
```

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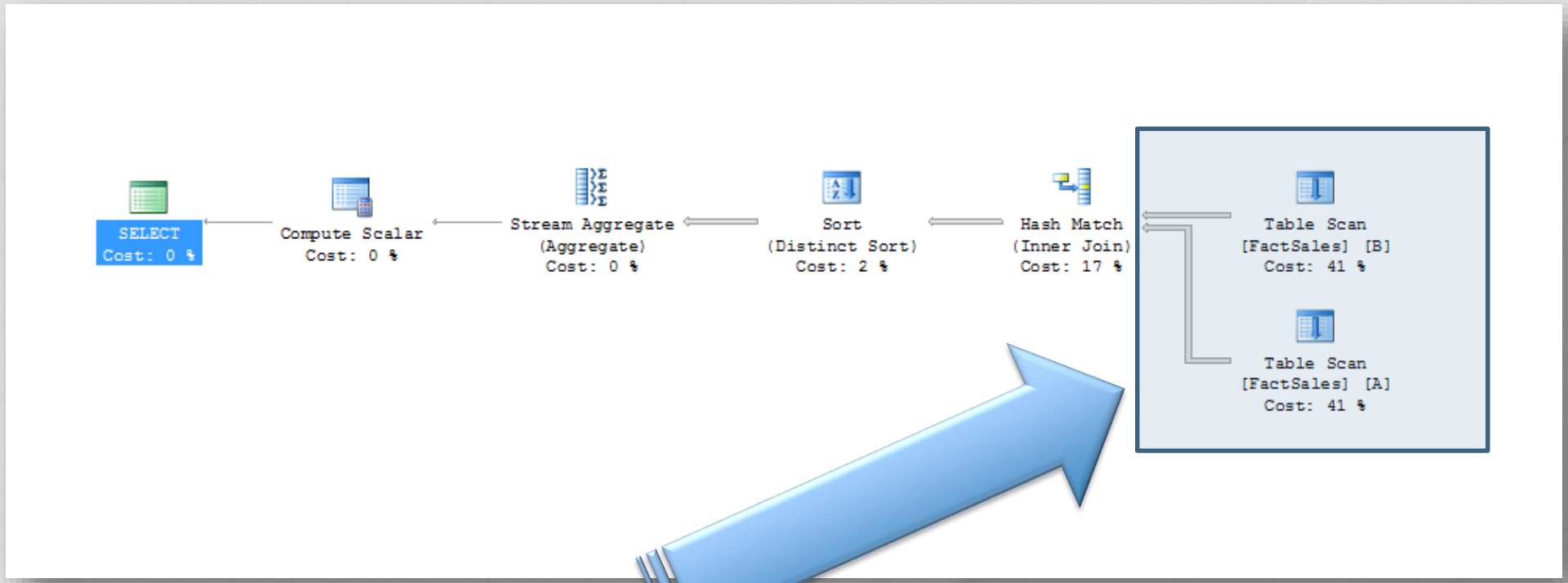
Look the query plan…



This is the fact table…
Do you really like to self-join it?

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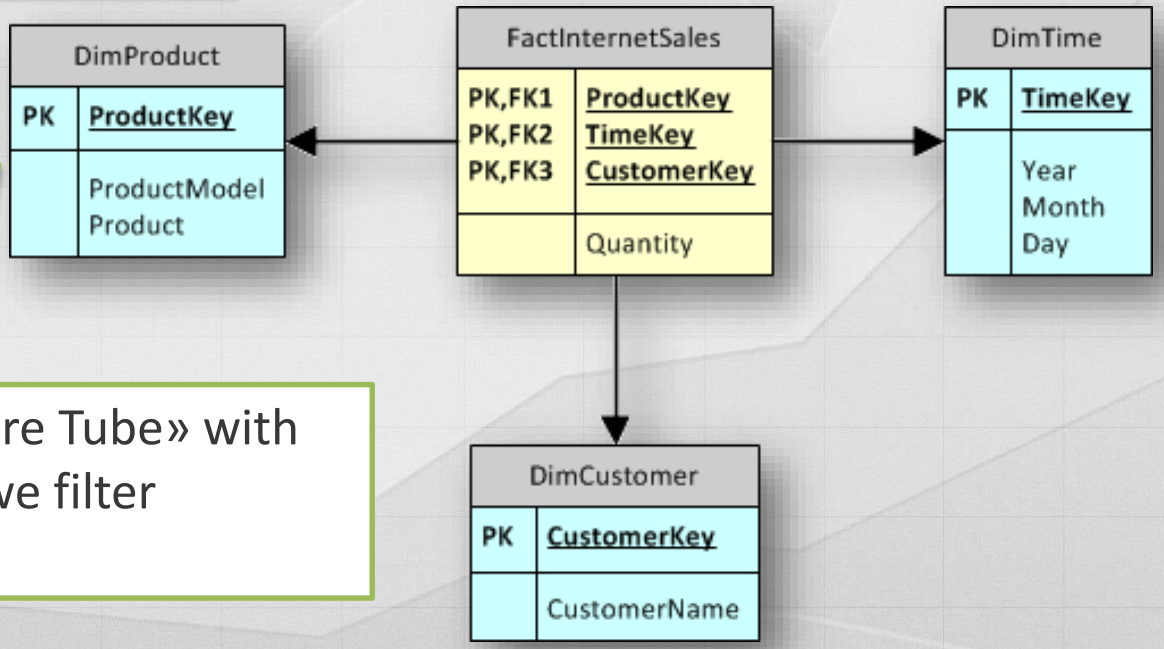
Basket Analysis: The Data Model

*Of all the customers who have bought a **Mountain Bike**, how many have never bought a **mountain tire tube**?*



We can filter «Mountain Tire Tube» with this table but… where do we filter «Mountain Bike»?

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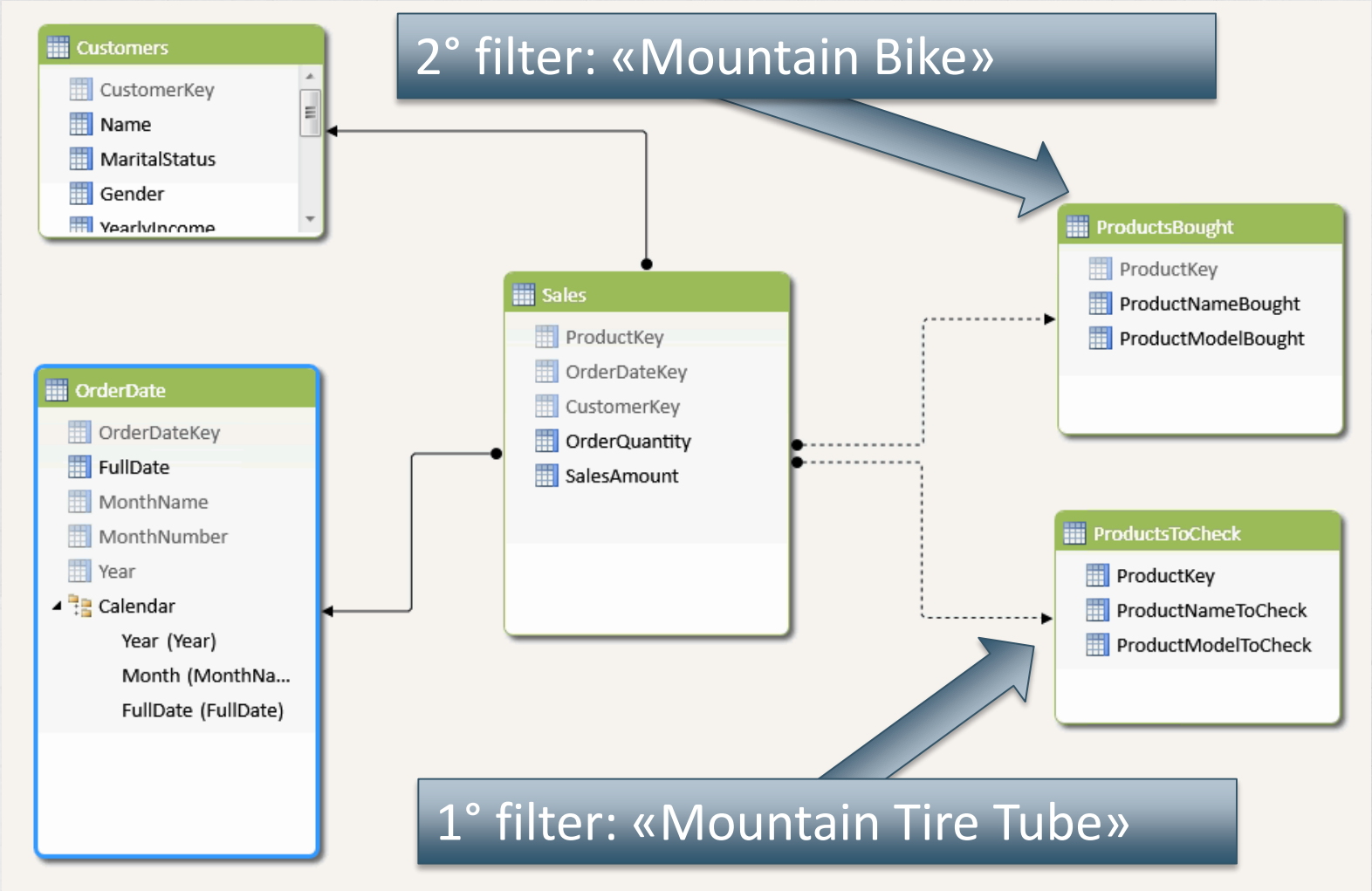
Basket Analysis: The Data Model



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The Final Result

2° filter: «Mountain Tire Tube»

ProductModelToCheck

Men's Sports Shorts	Minipump	ML Bottom Bracket	ML Crankset	ML Fork	ML Headset
ML Mountain Frame	ML Mountain Frame-W	ML Mountain Front Wheel	ML Mountain Handlebars	ML Mountain Pedal	ML Mountain Rear Wheel
ML Mountain Seat/Saddl...	ML Mountain Tire	ML Road Frame	ML Road Frame-W	ML Road Front Wheel	ML Road Handlebars
ML Road Pedal	ML Road Rear Wheel	ML Road Seat/Saddle 2	ML Road Tire	ML Touring Seat/Saddle	Mountain Bike Socks

ProductModelBo...

- ML Road Rear ...
- ML Road Seat/...
- ML Road Tire
- ML Touring Se...
- Mountain Bike...
- Mountain Bott...
- Mountain Pump
- Mountain Tire ...
- Mountain-100
- Mountain-200
- Mountain-300
- Mountain-400...
- Mountain-500
- Patch kit
- Racing Socks
- Rear Brakes

Row Labels	Column Labels: Mountain Tire Tube HavingProduct	NotHavingProduct	Total HavingProduct	Total NotHavingProduct
2007	**33**	**174**	**33**	**174**
Mountain-400-W Silver, 38	9	48	9	48
Mountain-400-W Silver, 40	8	42	8	42
Mountain-400-W Silver, 42	7	41	7	41
Mountain-400-W Silver, 46	9	43	9	43
2008	**83**	**460**	**83**	**460**
Mountain-400-W Silver, 38	26	122	26	122
Mountain-400-W Silver, 40				
Mountain-400-W Silver, 42				
Mountain-400-W Silver, 46				
2009				
Mountain-400-W Silver, 38				
Mountain-400-W Silver, 40	20	108	20	108
Mountain-400-W Silver, 42	21	108	21	108
Mountain-400-W Silver, 46	16	122	16	122
2010	**83**	**460**	**83**	**460**
Mountain-400-W Silver, 38	26	122	26	122
Mountain-400-W Silver, 40	20	108	20	108
	21	108	21	108
	16	122	16	122
	83	**460**	**83**	**460**

HavingProduct = Bought Both

NotHavingProduct = Bought Bike, No Tire

1° filter: «Mountain Bike»

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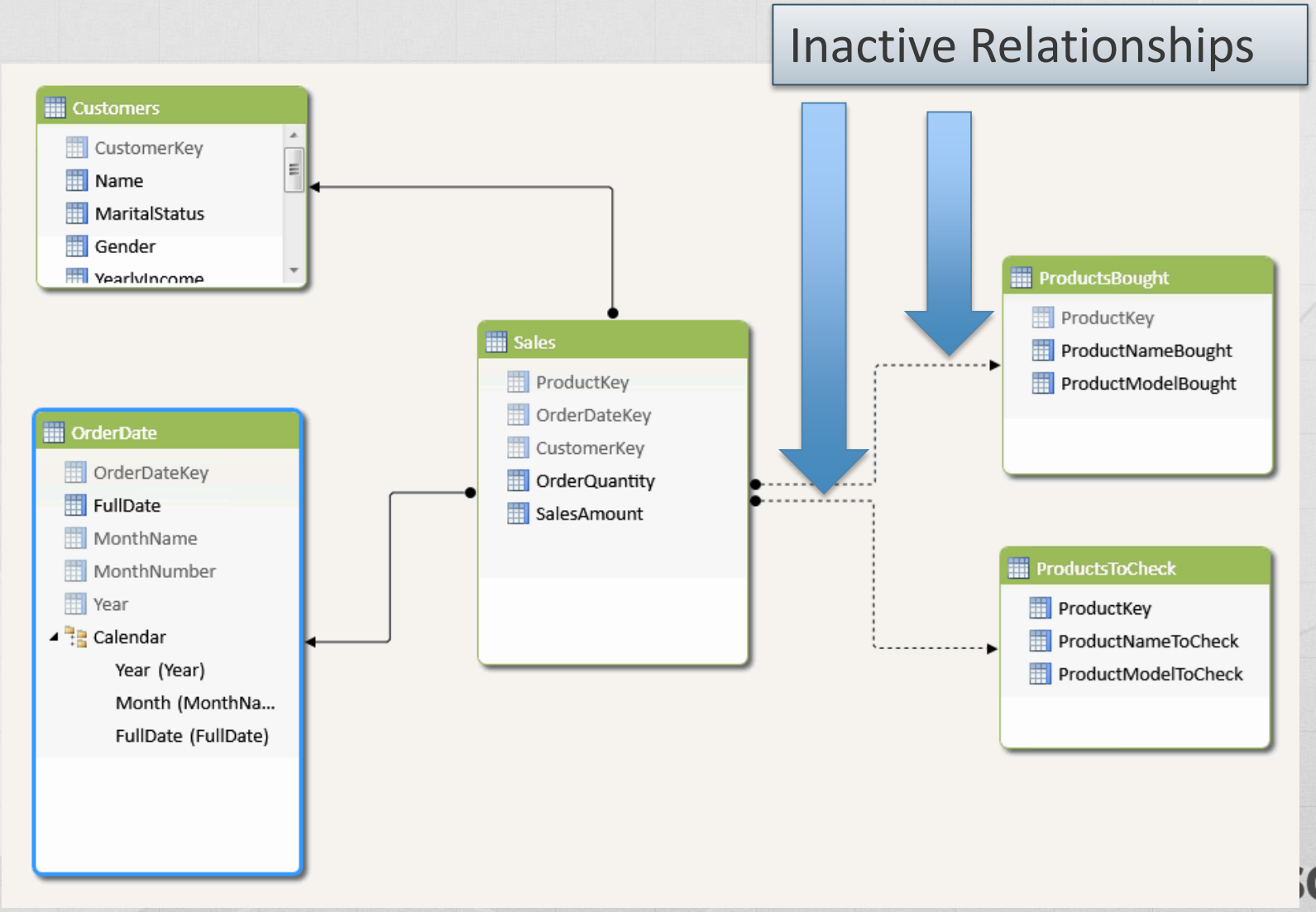
Inactive Relationships



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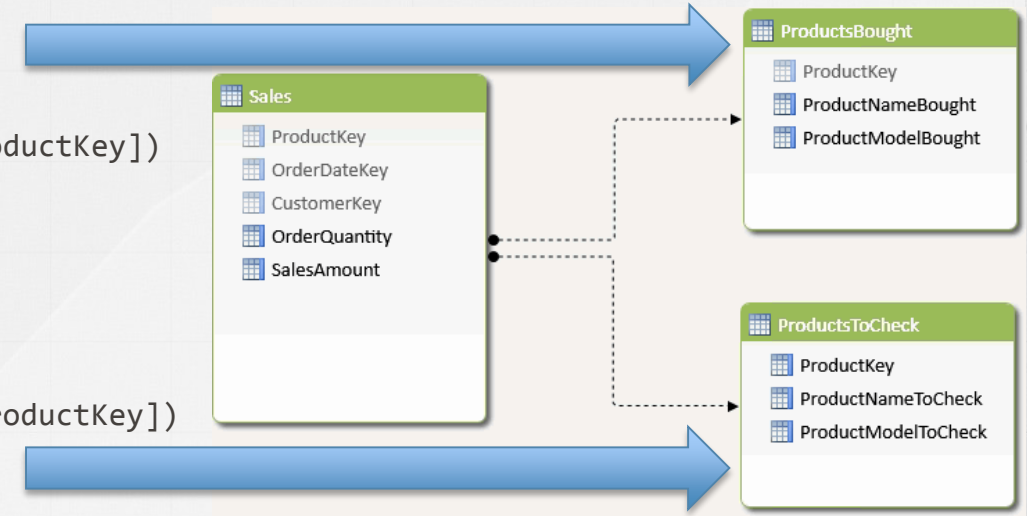
The formula for HavingProducts

```
=COUNTROWS (
    CALCULATETABLE (
        FILTER (
            Customers;
            CALCULATE (
                COUNTROWS (Sales);
                USERELATIONSHIP (
                    Sales[ProductKey];
                    ProductsBought[ProductKey])
            ) > 0
            &&
            CALCULATE (
                COUNTROWS (Sales);
                USERELATIONSHIP (
                    Sales[ProductKey];
                    ProductsToCheck[ProductKey])
            ) > 0
        );
        FILTER (
            ALL (OrderDate);
            OrderDate[FullDate] <= MAX (OrderDate[FullDate])
        )
    )
)
```



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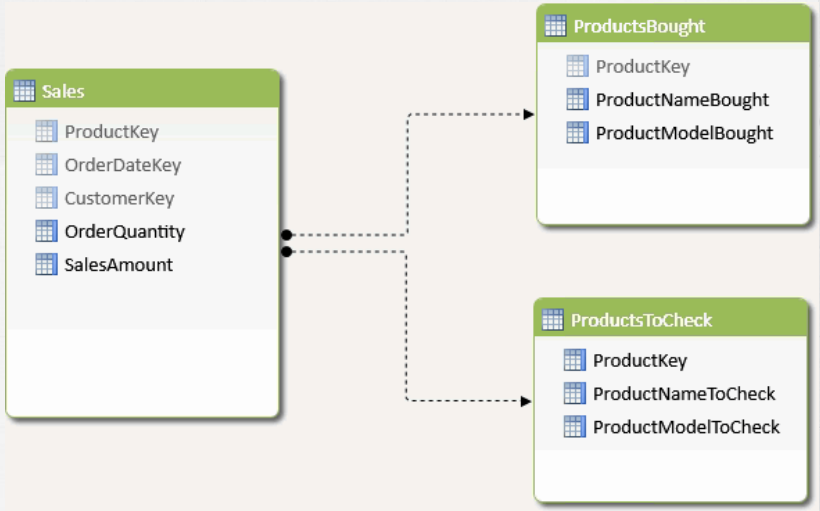
Not HavingProducts

```
=COUNTROWS (
    CALCULATETABLE (
        FILTER (
            Customers;
            CALCULATE (
                COUNTROWS (Sales);
                USERELATIONSHIP (
                    Sales[ProductKey];
                    ProductsBought[ProductKey])
            ) > 0
            &&
            CALCULATE (
                COUNTROWS (Sales);
                USERELATIONSHIP (
                    Sales[ProductKey];
                    ProductsToCheck[ProductKey])
            ) = 0
        );
        FILTER (
            ALL (OrderDate);
            OrderDate[FullDate] <= MAX (OrderDate[FullDate])
        )
    )
)
```



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Nice, and the many-to-many?

Where are the many-to-many patterns in this formula?

```
=COUNTROWS (
    CALCULATETABLE (
        FILTER (
            Customers;
            CALCULATE (
                COUNTROWS (Sales);
                USERELATIONSHIP (
                    Sales[ProductKey];
                    ProductsBought[ProductKey])
            ) > 0
            &&
            CALCULATE (
                COUNTROWS (Sales);
                USERELATIONSHIP (
                    Sales[ProductKey];
                    ProductsToCheck[ProductKey])
            ) = 0
        );
        FILTER (
            ALL (OrderDate);
            OrderDate[FullDate] <= MAX (OrderDate[FullDate])
        )
    )
)
```

1° M2M Pattern

2° M2M Pattern

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Leveraging Tabular Features

- Multiple relationships between tables
  - Role Dimensions
  - Role Keys
- Active / Inactive relationships
- USERELATIONSHIP
  - New filter function
  - Selects a model relationship to use in calculations

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Many to Many - Conclusions

- Learn with COUNTROWS
- Implement with SUMMARIZE
  - Faster
  - More concise
- If SUMMARIZE is not enough
  - Revert back to COUNTROWS
- Many powerful patterns with many-to-many
- Very fast in Tabular when compared with Multidimensional

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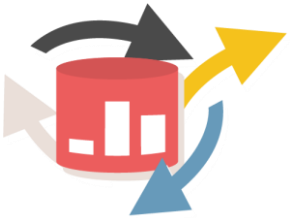
Assessment



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