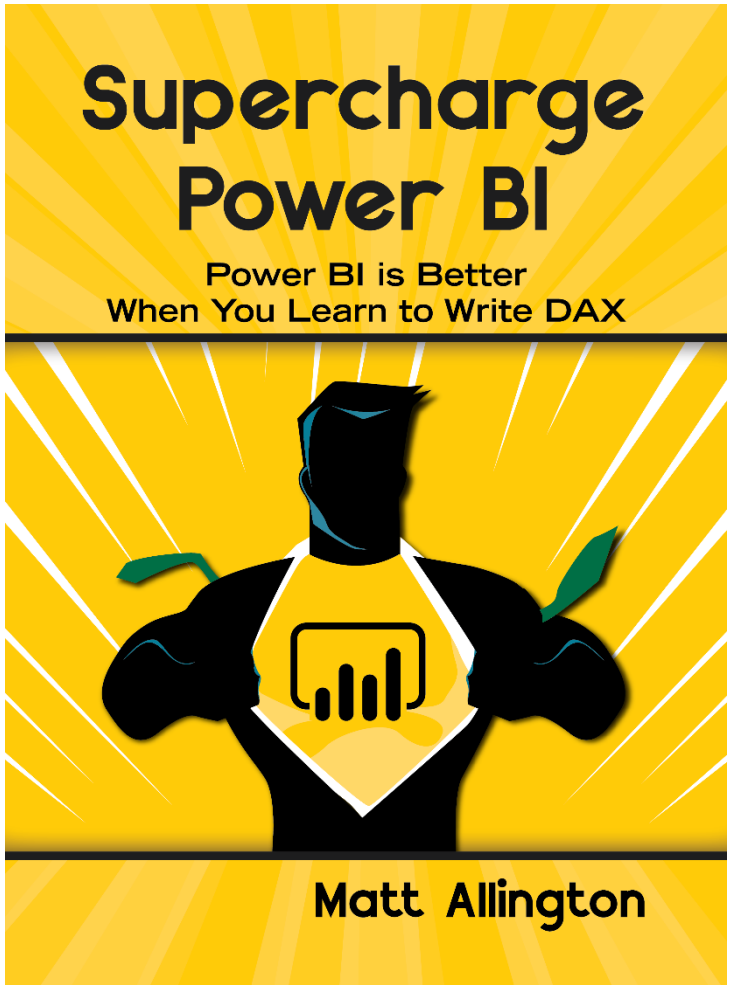
# Supercharge Power BI

## Power BI is better When you Learn to Write DAX

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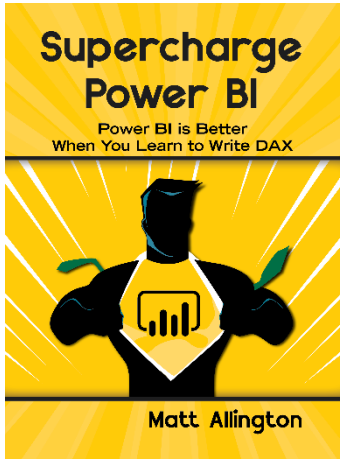
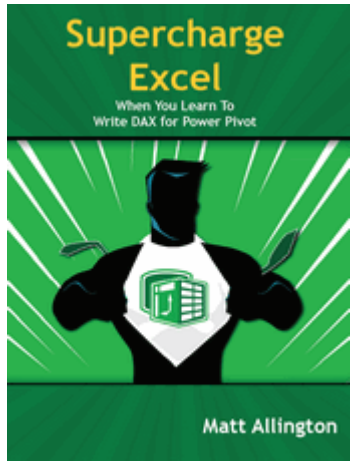
# About me

- 25 year career at Coca-Cola working in both Sales and Information Technology
- Now running a Power BI consultancy in Sydney Australia
  - Self Service BI Consulting
  - Power Pivot/Power BI Training
  - Blogger http://xbi.com.au/blog
- Author
- Microsoft MVP


@ExceleratorBI

https://au.linkedin.com/in/mattallington

http://xbi.com.au

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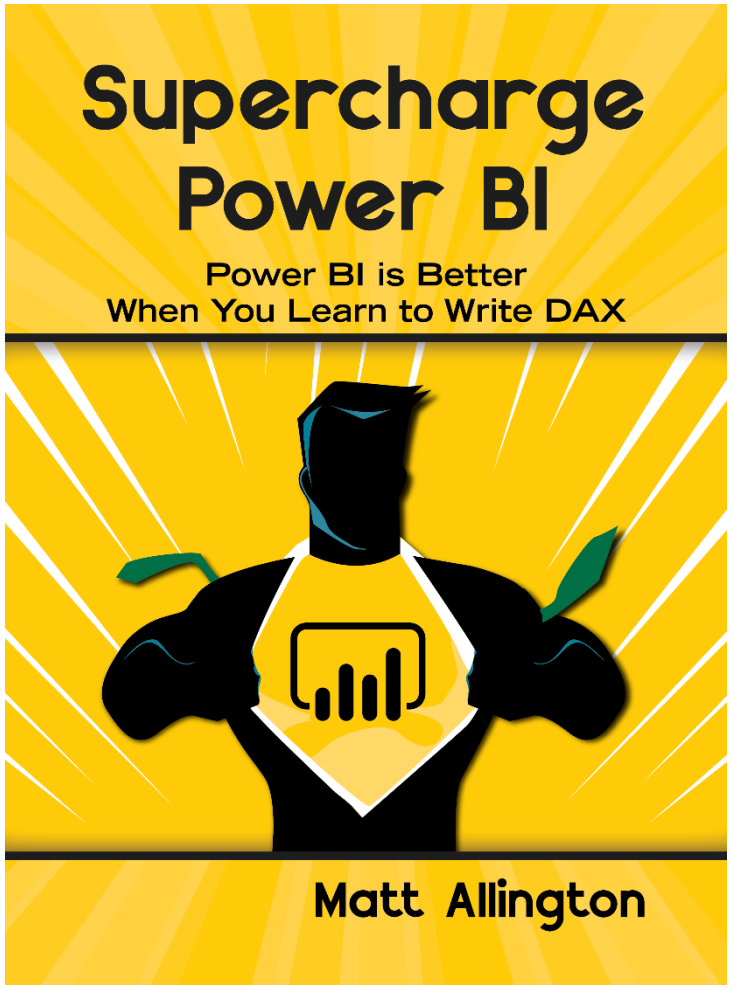
# Supercharge Power BI Online

# Kick-off Meeting

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# Objective of This Call

To ensure you have all you need to start the learning process.

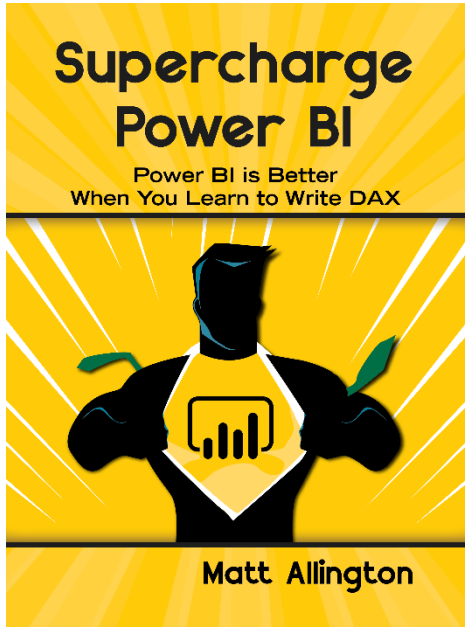
# Why are you here?

**Because you want to be a Power BI/Power Pivot super star**

This course will provide you with

- Guided self learning
- Explanation of the harder to learn concepts from an experienced teacher.
- Live support for all your questions
- You will learn Power BI and the DAX language

**Select the best book for your learning needs**

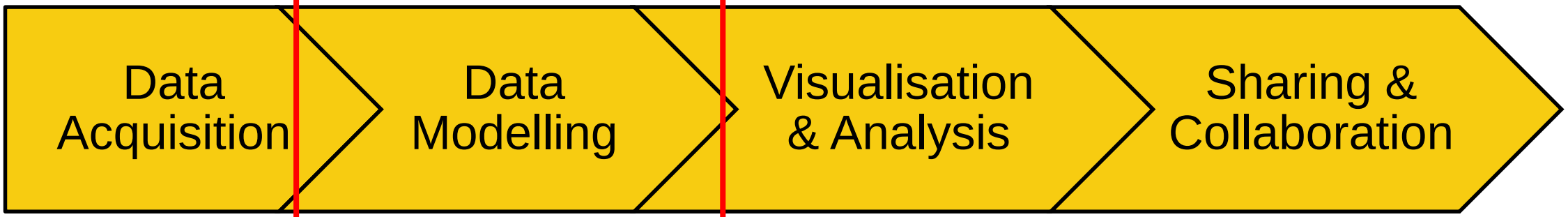



# Power BI Is An End to End BI Ecosystem

## The 4 stages of Power BI

http://xbi.com.au/pqt

We are focussing here




| | | | |
|---|---|---|---|
| Connect<br>Clean<br>Shape<br>Load | Relationships<br>Business rules<br>Turn raw data into usable assets | Reports<br>Dashboards<br>Data exploration | PowerBI.com |

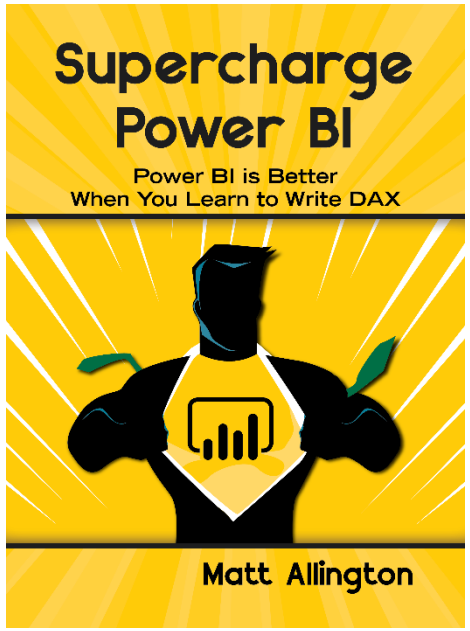
# What is Data Modelling?

Data Modelling is a new term for most Excel Professionals

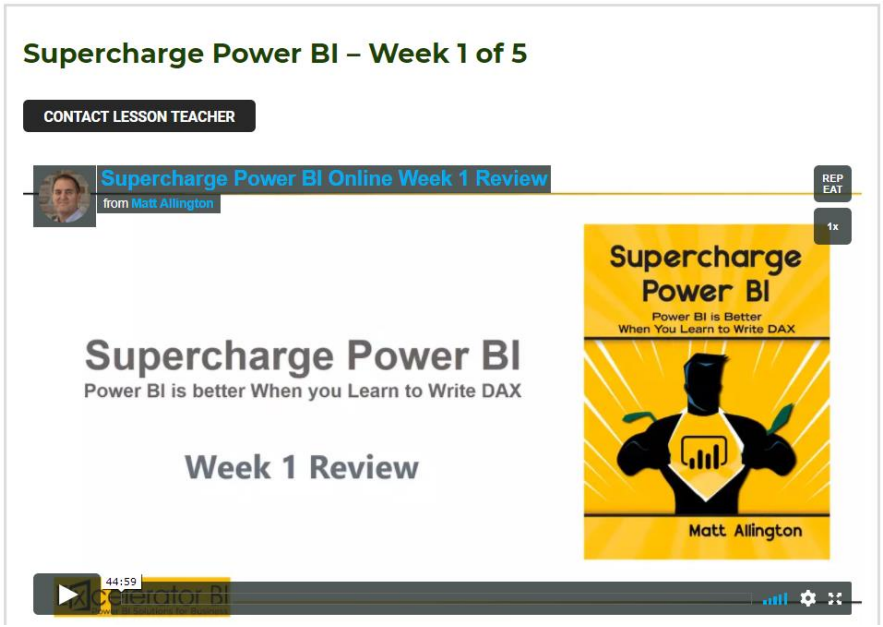
- Deciding which data to load
- Deciding in which tables and columns to put the data
- Creating relationships between tables
- Applying business logic to the data to create measures
- Assigning meaningful business names
- Applying suitable formatting

# Weekly Learning Cycle

1. Read prescribed chapters




2. Watch the weekly video summary




3. Attend the weekly live Q&A session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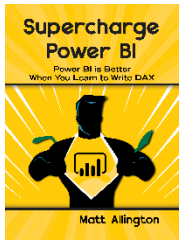
# Weekly Agenda – Supercharge Power BI






## Weekly Video + Q&A Topics

1. Loading Data, Basic Measures, Aggregation Functions
2. Filter Propagation, Evaluation Contexts, Iterating Functions, CALCULATE() explained
3. SWITCH, VALUES, ALL, Evaluation Context and Context Transition
4. FILTER(), Time Intelligence, Custom Time Intelligence Explained
5. Multiple Data Tables, Writing Cube Formulas from scratch, Final questions, Next steps

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# Weekly Agenda – Supercharge Excel




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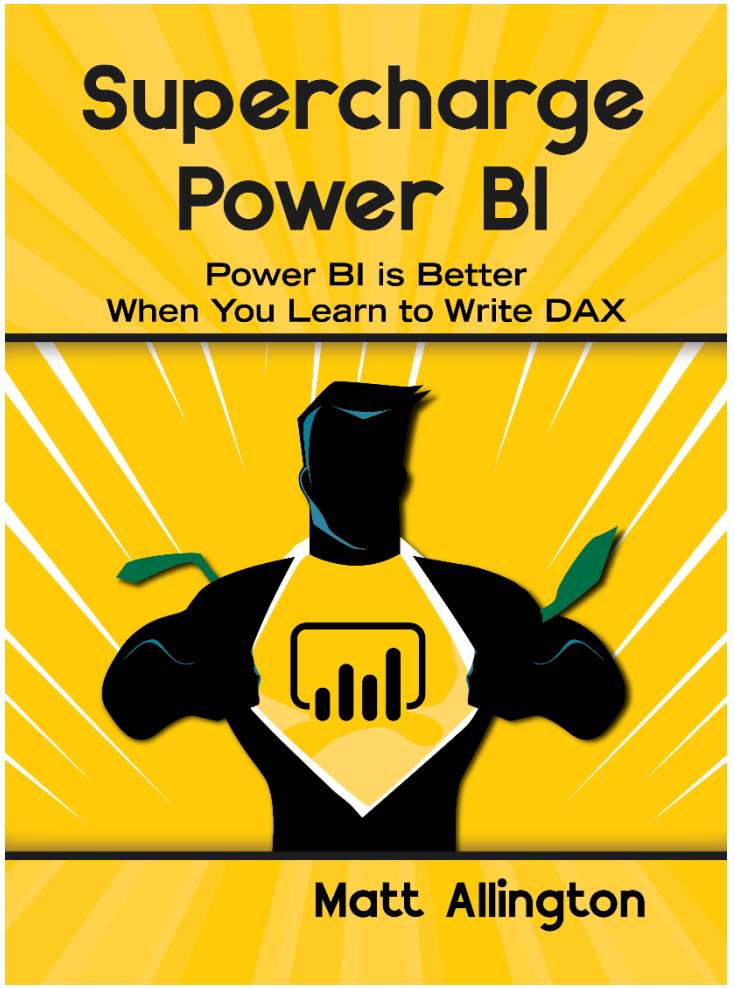
# Supercharge Power BI Online

# Week 1 Review

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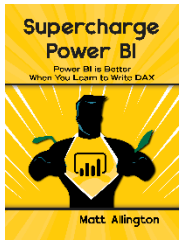
# Week 1 Topics – Supercharge Power BI






## Weekly Video + Q&A Topics

1. Loading Data, Basic Measures, Power BI Desktop

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# Week 1 Topics – Supercharge Excel




## Weekly Video + Q&A Topics

1. Loading Data, Basic Measures, Aggregation Functions

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# Measures vs Calculated Fields

- Excel 2010, 2016, Power BI Desktop
  - All use the term “Measures”
- Excel 2013
  - Uses the term “Calculated Fields”
- I always use the term Measures now

# Important Concept
## Data tables vs. Lookup tables

### Data Tables

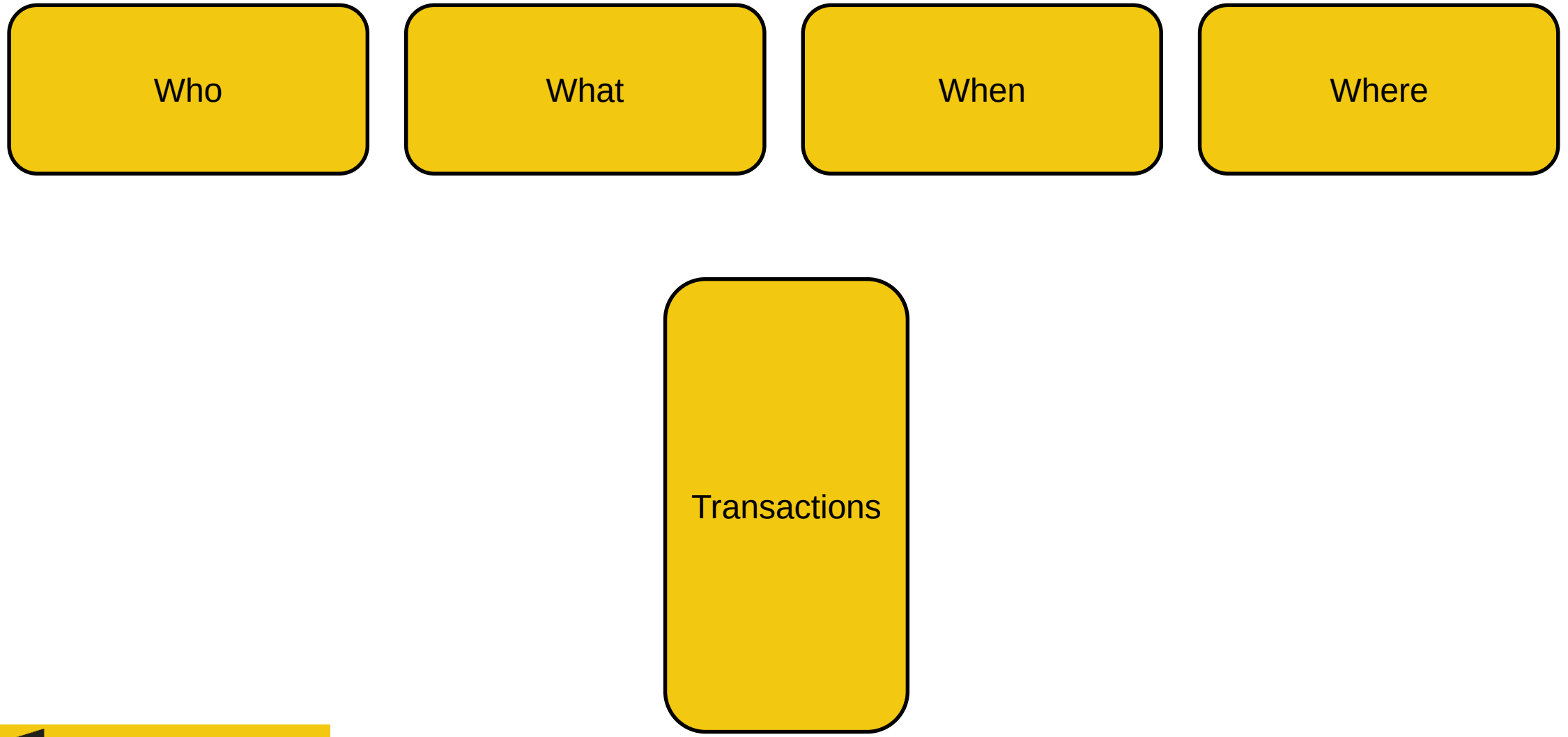
- Contain the numbers about “transactions”
- Sales, Budget, Inventory, etc.
- Sometimes called “fact” tables
- Measures/calc fields tend to come from data tables
- Can contain many millions of rows
- Each item can occur many times

### Lookup Tables

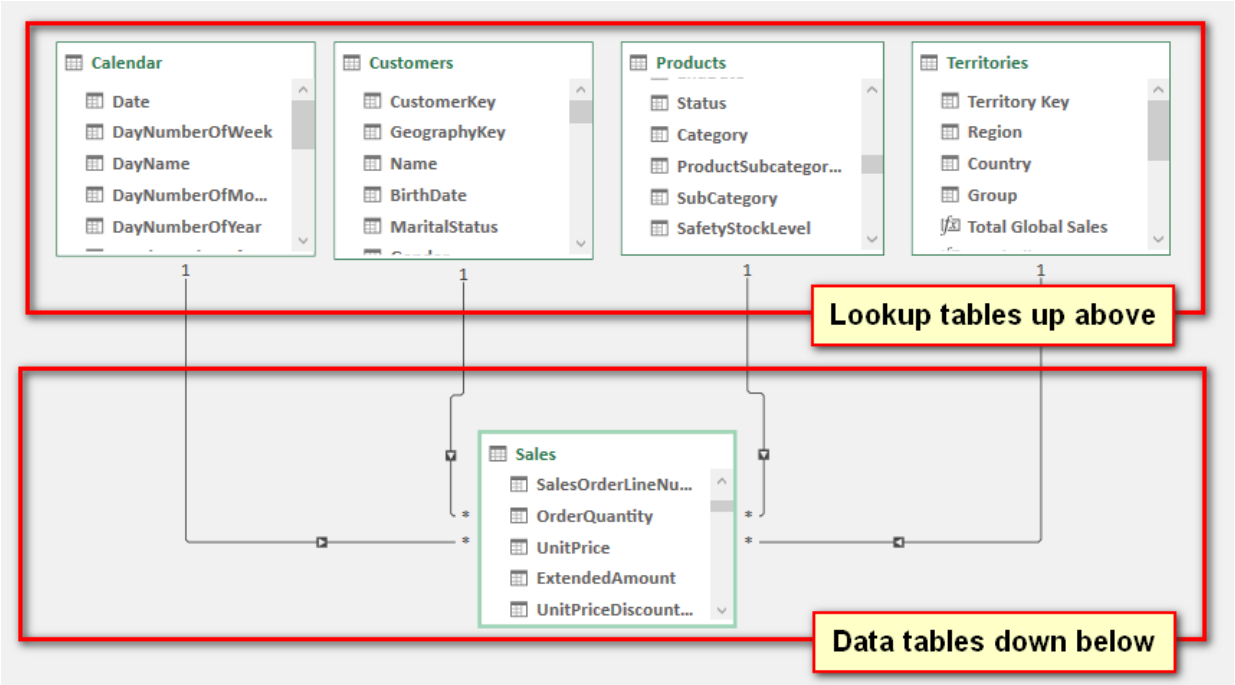
- Tend to have fewer rows than data tables
- Calendar, Customers, Stores, Products, etc.
- Sometimes called “dimension,” “reference,” or “master” tables
- Row, Column, Report Filter, and Slicer fields

- Each item can occur only once.

# Planning

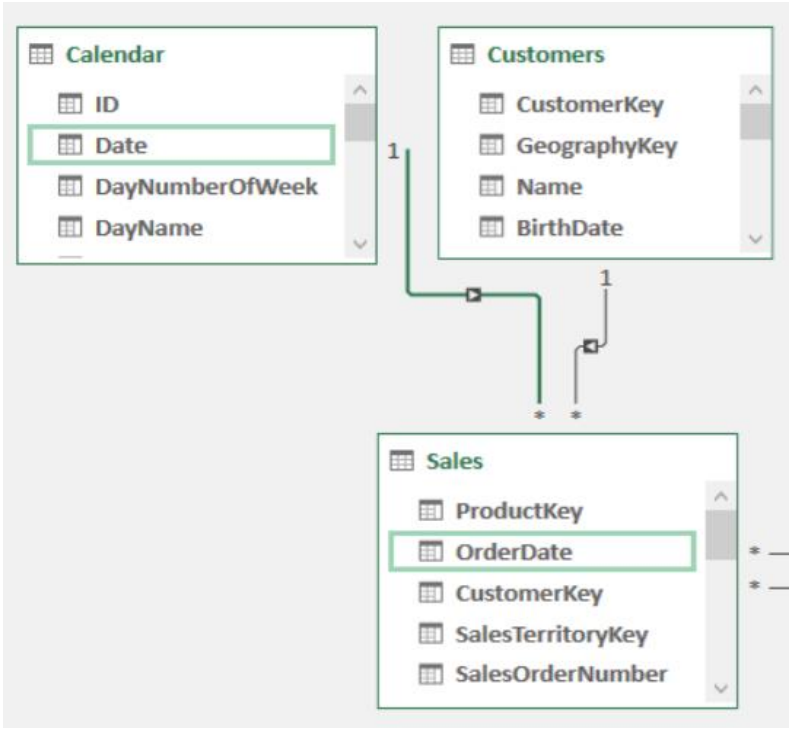


# Laying Out Your Tables

# Key things to note

- You can have only1 ***active*** relationship between any two tables and it must be a 1 to many relationship



# Compare:  Calc Columns vs Measures

## Calc columns are:

- Properties of each individual row of a table
- Can be used on row/column/filter/slicer
  - E.g.  good for grouping
- Pre-calculated and stored
  - Answers are saved as part of the file
  - Answers only change in the table when the data is refreshed

## Measures (calc fields) are:

- This is the big new thing in Power Pivot
- Can only be used in the Values area
- Never pre-calculated, always built on the fly
- The answer is recalculated in response to
  - Filters, slicers, pivot table layout.
- Can be used over and over in different pivots

# Best practice summary

- Rename your tables and columns early (Excel 2013 and earlier)
- Don’t use spaces in table names
- Don’t use prefixes (e.g. dim, fct) on your table names
- Only bring in the columns of data you need
  - It is easy to bring in new columns later
- Place your lookup tables at the top, and the data tables underneath.

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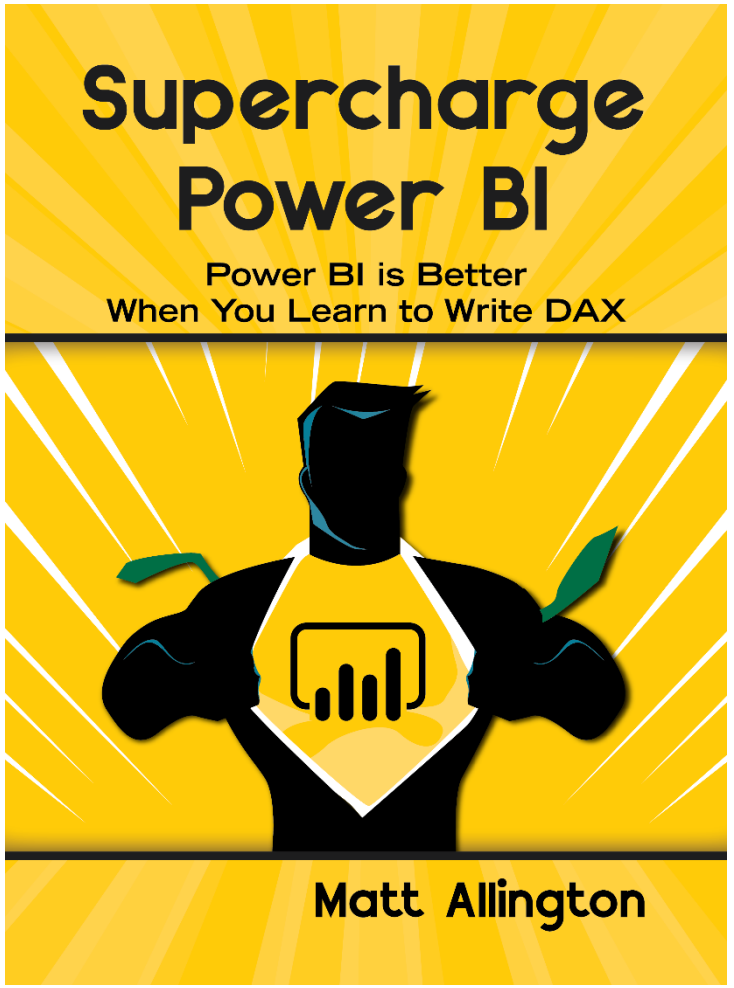
# Week 2 Review

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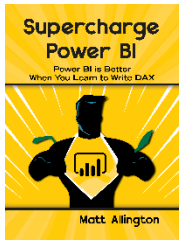
# Week 2 Topics – Supercharge Power BI






## Weekly Video + Q&A Topics

1. Loading Data, Basic Measures, Power BI Desktop
2. Filter Propagation, Evaluation Contexts, Iterating functions, CALCULATE() explained

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# Week 2 Topics – Supercharge Excel




## Weekly Video + Q&A Topics

1. Loading Data, Basic Measures, Aggregation Functions
2. Filter Propagation, Evaluation Contexts, Iterating Functions, CALCULATE() explained

# Evaluation Contexts

**Not so confusing when you know what this means**

# What Do I Mean by Context?

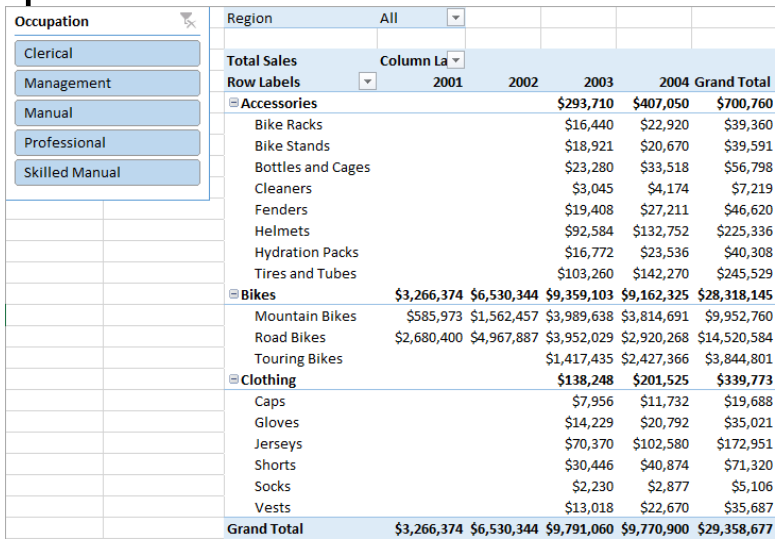
Take the phrase: *I'm Hot!*

# Evaluation Contexts

## Every formula can have a different result depending on the context

## Filter Context

- Filter context is provided by the coordinates of the pivot table



Occupation: Clerical, Management, Manual, Professional, Skilled Manual

| Region | All | | | | |
|---|---|---|---|---|---|
| Total Sales | Column La | | | | |
| Row Labels | 2001 | 2002 | 2003 | 2004 | Grand Total |
| **Accessories** | | | **$293,710** | **$407,050** | **$700,760** |
| Bike Racks | | | $16,440 | $22,920 | $39,360 |
| Bike Stands | | | $18,921 | $20,670 | $39,591 |
| Bottles and Cages | | | $23,280 | $33,518 | $56,798 |
| Cleaners | | | $3,045 | $4,174 | $7,219 |
| Fenders | | | $19,408 | $27,211 | $46,620 |
| Helmets | | | $92,584 | $132,752 | $225,336 |
| Hydration Packs | | | $16,772 | $23,536 | $40,308 |
| Tires and Tubes | | | $103,260 | $142,270 | $245,529 |
| **Bikes** | **$3,266,374** | **$6,530,344** | **$9,359,103** | **$9,162,325** | **$28,318,145** |
| Mountain Bikes | $585,973 | $1,562,457 | $3,989,638 | $3,814,691 | $9,952,760 |
| Road Bikes | $2,680,400 | $4,967,887 | $3,952,029 | $2,920,268 | $14,520,584 |
| Touring Bikes | | | $1,417,435 | $2,427,366 | $3,844,801 |
| **Clothing** | | | **$138,248** | **$201,525** | **$339,773** |
| Caps | | | $7,956 | $11,732 | $19,688 |
| Gloves | | | $14,229 | $20,792 | $35,021 |
| Jerseys | | | $70,370 | $102,580 | $172,951 |
| Shorts | | | $30,446 | $40,874 | $71,320 |
| Socks | | | $2,230 | $2,877 | $5,106 |
| Vests | | | $13,018 | $22,670 | $35,687 |
| **Grand Total** | **$3,266,374** | **$6,530,344** | **$9,791,060** | **$9,770,900** | **$29,358,677** |

- CALCULATE is used to change the filter context coming from the pivot table.
- Filter context follows relationships from the 1 side to the many side.

## Row Context

- Exists in
  - a Calculated Column
  - Some “special” DAX Functions *

| SalesAmount | GST | Freight | RegionMonthID | Sales less GST |
|---|---|---|---|---|
| 564.99 | 45.1992 | 14.1248 | Australia6 | 519.7908 |
| 564.99 | 45.1992 | 14.1248 | Australia6 | 519.7908 |
| 24.49 | 1.9592 | 0.6123 | Australia6 | 22.5308 |
| 8.99 | 0.7192 | 0.2248 | Australia6 | 8.2708 |
| 8.99 | 0.7192 | 0.2248 | Australia6 | 8.2708 |
| 564.99 | 45.1992 | 14.1248 | Australia6 | 519.7908 |
| 53.99 | 4.3192 | 1.3498 | Australia6 | 49.6708 |
| 53.99 | 4.3192 | 1.3498 | Australia6 | 49.6708 |
| 120 | 9.6 | 3 | Australia6 | 110.4 |
| 7.95 | 0.636 | 0.1988 | Australia6 | 7.314 |
| 24.49 | 1.9592 | 0.6123 | Australia6 | 22.5308 |

- A row context
  - does not follow relationships
  - does not create a Filter Context
- CALCULATE is used to create **context transition**

# Row Context Summary

- A row context exists in
  - a calculated column
  - Iterating functions like SUMX, FILTER etc
- Does not exist in a regular measure
  - You can't use naked columns in a regular measure
  - Regular measures only operate on columns and/or tables
  - There is no concept of row-wise evaluation in a regular measure

[Sales Amoun... =Sales[OrderQuantity] * Sales[UnitPrice]

| | | TotalProductCost | TaxAmt | Freight | RegionMonthID | Sales Amount 2 |
|---|---|---|---|---|---|---|
| 1 | 8.99 | 6.9223 | 0.7192 | 0.2248 | Canada7 | 8.99 |
| 2 | 159 | 59.466 | 12.72 | 3.975 | Canada7 | 159 |
| 3 | 21.98 | 8.2205 | 1.7584 | 0.5495 | Canada7 | 21.98 |
| 4 | 8.99 | 6.9223 | 0.7192 | 0.2248 | Canada7 | 8.99 |
| 5 | 21.98 | 8.2205 | 1.7584 | 0.5495 | Canada7 | 21.98 |
| 6 | 34.99 | 13.0863 | 2.7992 | 0.8748 | Canada7 | 34.99 |
| 7 | 35 | 13.09 | 2.8 | 0.875 | Canada7 | 35 |
| 8 | 4.99 | 1.8663 | 0.3992 | 0.1248 | Canada7 | 4.99 |
| 9 | 8.99 | 6.9223 | 0.7192 | 0.2248 | Canada7 | 8.99 |
| 10 | 53.99 | 41.5723 | 4.3192 | 1.3498 | Canada7 | 53.99 |
| 11 | 21.98 | 8.2205 | 1.7584 | 0.5495 | Canada7 | 21.98 |
| 12 | 2.29 | 0.8565 | 0.1832 | 0.0573 | Northwest7 | 2.29 |
| 13 | 35 | 13.09 | 2.8 | 0.875 | Northwest7 | 35 |
| 14 | 4.99 | 1.8663 | 0.3992 | 0.1248 | Northwest7 | 4.99 |
| 15 | 120 | 44.88 | 9.6 | 3 | Germany7 | 120 |
| 16 | 7.95 | 2.9733 | 0.636 | 0.1988 | Germany7 | 7.95 |
| 17 | 2.29 | 0.8565 | 0.1832 | 0.0573 | Germany7 | 2.29 |

```
Total Sales SumX version:=sumx(sales,Sales[OrderQuantity] * Sales[UnitPrice] )
```

Formula: Check DAX Formula

```
=Sales[OrderQuantity] * Sales[UnitPrice]
```

This formula is invalid or incomplete: 'Calculation error in measure 'Sales'[Total Sales ]: A single value for column 'OrderQuantity' in table 'Sales' cannot be determined. This can happen when a measure formula refers to a column that contains many values without

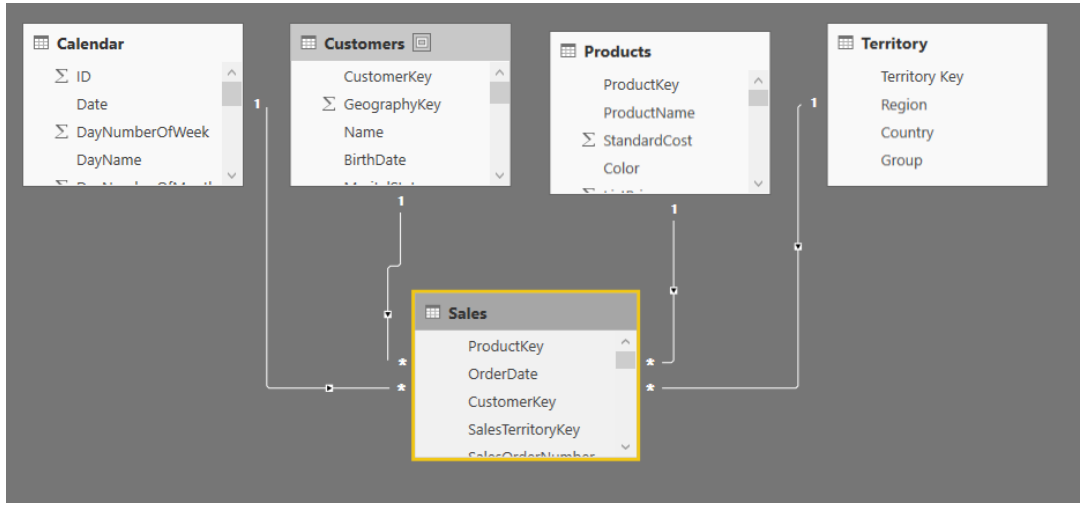
Category:

# Filter Context Summary

- A filter context exists in
  - All visuals in Power BI
  - A Pivot Table in Excel

| Row Labels | Total Products | Total Sales | Total Customers |
|---|---|---|---|
| Accessories | 35 | $700,760 | 18,484 |
| Bikes | 125 | $28,318,145 | 18,484 |
| Clothing | 48 | $339,773 | 18,484 |
| Components | 189 | | 18,484 |
| **Grand Total** | **397** | **$29,358,677** | **18,484** |

- A filter context propagates from the one side to the many side of relationships (flows downhill).
- Can also be bi-directional in PBI



# Function: CALCULATE()

=CALCULATE(<measure expression>, <filter1>, <filter2>,…)

<measure expression> [Required]

Name of an existing measure, or formula that is valid for a measure

ex: [Total Sales]

ex: SUM(Sales[Sales Amount])

<simple filter> [Optional]

A simple filter expression like Table[Column] = <fixed value>

e.g.: Products[Category]="Clothing"

e.g.: Calendar[Year]=2003

<table filter> [Optional]

You provide a table function, and CALCULATE will apply that filter

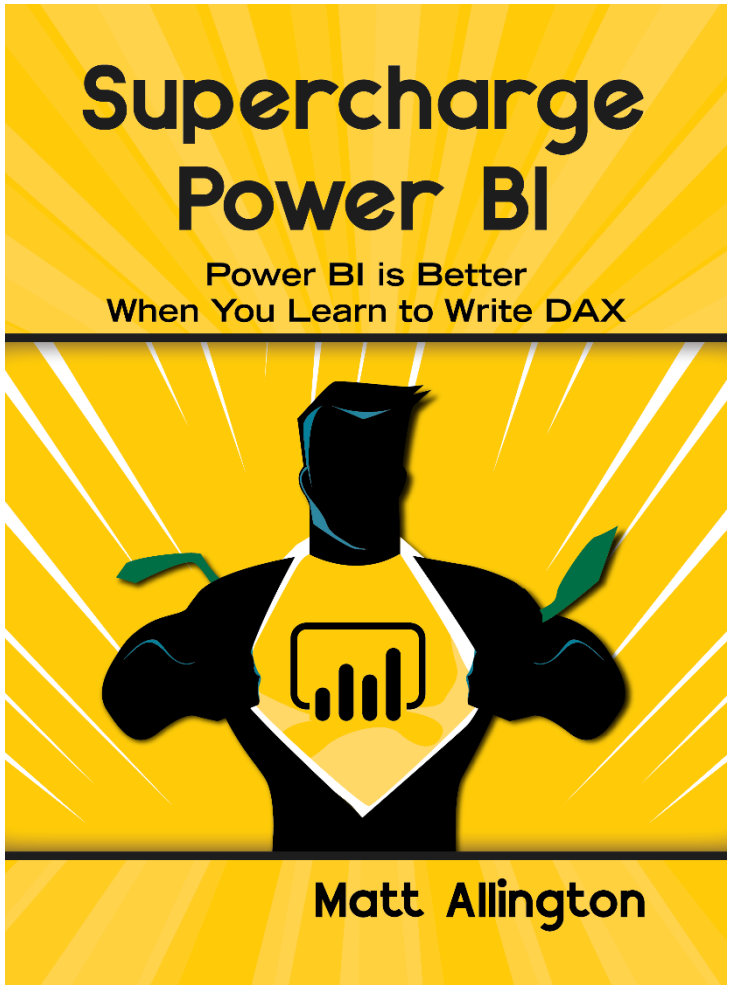
e.g.: ALL(Products)

e.g.: VALUES(Calendar[Day Name])

# What is this?

# Supercharge Power BI Online

# Week 3 Review

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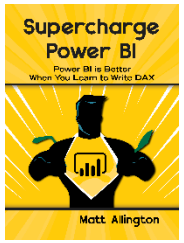
# Week 3 Topics – Supercharge Power BI






## Weekly Video + Q&A Topics

1. Loading data, basic measures, Power BI Desktop
2. CALCULATE() explained, Filter Propagation, Iterators revisited
3. SWITCH, VALUES, ALL, Evaluation Context and Context Transition

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# Week 3 Topics – Supercharge Excel




## Weekly Video + Q&A Topics

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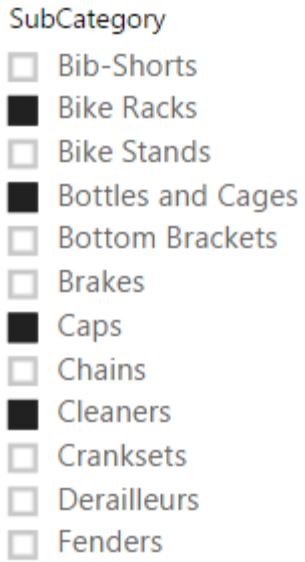
# Switch Function

- Allows you to pass an input, and get a different output
- A bit like
  - If 1, then give me X
  - If 2, then give me Y
  - If 3, give me something else etc

- Over to Power BI Desktop for a Demo

# VALUES is a very interesting function

- Returns single-column table of all values that are “active” in the current filter context



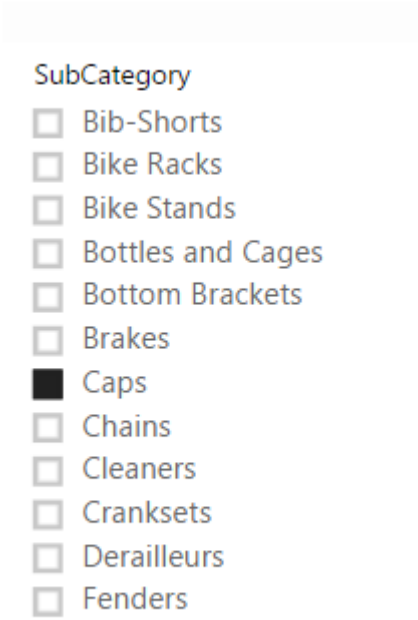

Virtual Table

| Values(Product[SubCategory]) |
| --- |
| Bike Racks |
| Bottles and Cages |
| Caps |
| Cleaners |

http://www.powerpivotpro.com/2014/08/the-many-faces-of-values/

# VALUES Special Use Case

- If there is only a single row in the table, you can access it as a value, not a table




You get this

| Values(Product[SubCategory]) |
| --- |
| Caps |

- You need to protect it with IF(HASONEVALUE(),…,…..)

But at the same time, this.

“Caps”

- Let’s demo in Power BI

# ALL Function

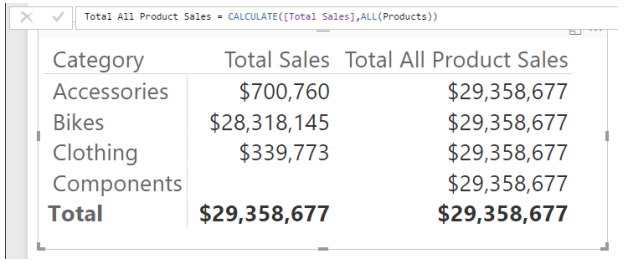
- Used primarily inside CALCULATE to remove filters
- Can be used to access the “Grand Total Row”

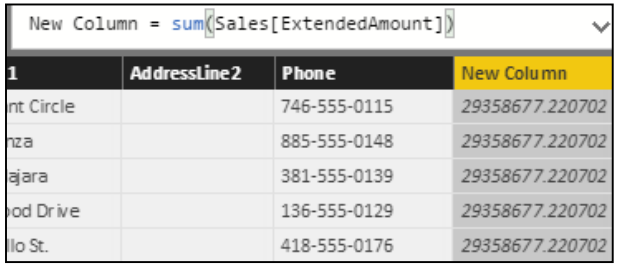
| Row Labels | Total Sales | % of all Product Sales |
|---|---|---|
| Accessories | $700,760 | 2.4% |
| Bikes | $28,318,145 | 96.5% |
| Clothing | $339,773 | 1.2% |
| **Grand Total** | **$29,358,677** | **100.0%** |

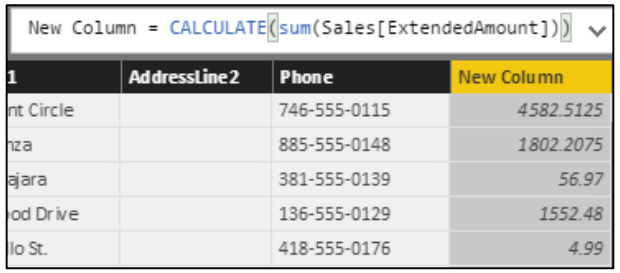
- Over to Excel for a Demo

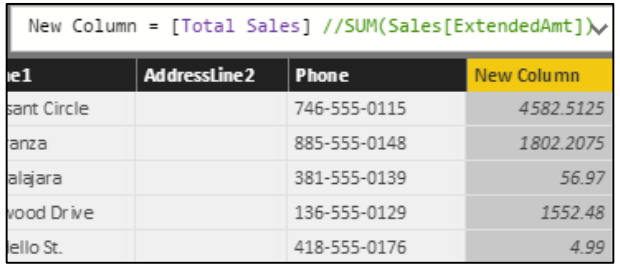
# CALCULATE and Context Transition Summary

- CALCULATE can modify the initial filter context by
  - Adding/Modifying/Removing initial filters
- A row context does not create a filter context.
- CALCULATE triggers context transition converting a row context into an equivalent filter context.
- Every measure has an implicit CALCULATE that you can't see, so measures always trigger context transition



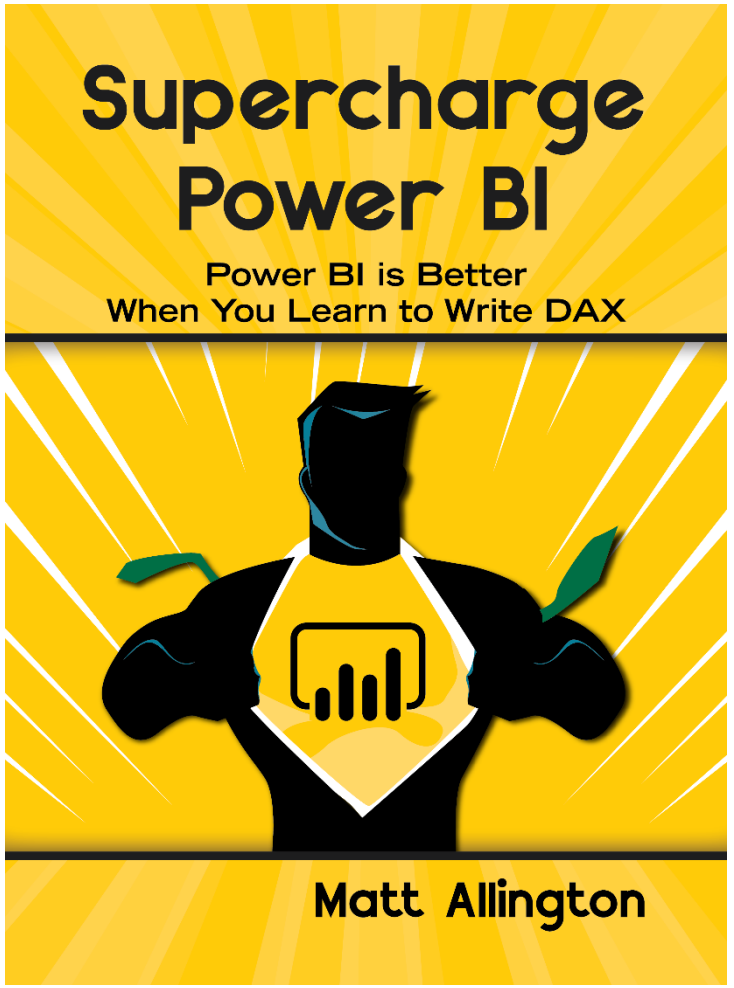



# Supercharge Power BI Online

# Week 4 Review

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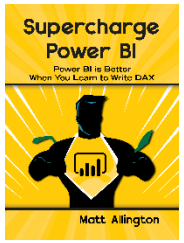
# Week 4 Topics – Supercharge Power BI






## Weekly Video + Q&A Topics

1. Loading Data, Basic Measures, Power BI Desktop
2. Filter Propagation, Evaluation Contexts, Iterating Functions, CALCULATE() explained
3. SWITCH, VALUES, ALL, Evaluation Context and Context Transition
4. FILTER(), Time Intelligence, Custom Time Intelligence Explained

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# Week 4 Topics – Supercharge Excel




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# FILTER function

- FILTER(<table expression>, <single, *rich* filter test>)

## <table expression>

- Name of a table, or formula expression that evaluates to a table
- ex:  Calendar
- ex:  VALUES(Calendar[Year])
- ex:  ALL(Calendar[Year])

## <single rich filter test>

- Anything that evaluates to True or False
- ex: [Total Sales Measure] < 50
- ex : SUM(SalesTable[ExtendedAmount]) > BudgetTable[Column1]
- ex : NOT(ISBLANK([Total Sales Measure]))
- ex : Table[Column1] <= Table[Column2] * 1.1
- ex: [Total Sales Measure] < 50 && [Total Sales Measure] > 0

## Operation

- Steps through every row (or value) in <table expression>
- Evaluates <rich filter test> at each step, in the context of that current row/value
- Only keeps rows that return True

# FILTER() over the Customer Table - Doesn't work

```
Total Sales from High Value Customers Doesn't Work =
    CALCUATE([Total Sales],
        Filter(Customers,
            SUM(Sales[Extended Amount])>=2000
        )
    )
```

| CustomerKey | GeographyKey | Name |
|---|---|---|
| 11087 | 307 | Tamara Liang |
| 11412 | 121 | Sydney Bryant |
| 12975 | 312 | Marcus Wilson |

| OrderDate | ProductKey | CustomerKey | ExtendedAmount |
|---|---|---|---|
| 29/08/2015 | 486 | 11087 | 150.00 |
| 08/05/2016 | 351 | 11412 | 200.00 |
| 13/07/2016 | 371 | 12975 | 500.00 |
| 07/07/2016 | 375 | 11087 | 1100.00 |
| 10/07/2016 | 383 | 11412 | 1000.00 |
| 28/10/2016 | 385 | 12975 | 1500.00 |
| 11/07/2016 | 333 | 11087 | 700.00 |
| 04/07/2016 | 337 | 11412 | 500.00 |
| 18/07/2015 | 580 | 12975 | 250.00 |
| 18/12/2015 | 606 | 11087 | 550.00 |
| 08/12/2015 | 584 | 12975 | 850.00 |
| Total | | | 29.3 m |

# FILTER() over the Customer Table – Does work

```
Total Sales from High Value Customers =
    CALCUATE([Total Sales],
        Filter(Customers,
            CALCULATE(
                SUM(Sales[Extended Amount])
            )>= 2000                )
    )
```

| CustomerKey | GeographyKey | Name |
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| 18/07/2015 | 580 | 12975 | 250.00 |
| 18/12/2015 | 606 | 11087 | 550.00 |
| 08/12/2015 | 584 | 12975 | 850.00 |
| Total | | | 3100.00 |

# The last tricky thing

- All measures have an implicit CALCULATE

```
[Total Sales] =
    SUM(Sales[ExtendedAmount])
```

But what ACTUALLY you get is

```
[Total Sales] =
    CALCULATE(SUM(Sales[ExtendedAmount]))
```

Let's look inside the FILTER Function

# Time Intelligence

- Date/Calendar Tables
- Change versus Prior Month/Year Etc.
- Running totals
  - Year to Date, Month to Date, Quarter to Date
- Any other time shifting you can think of

# Rules of a date table

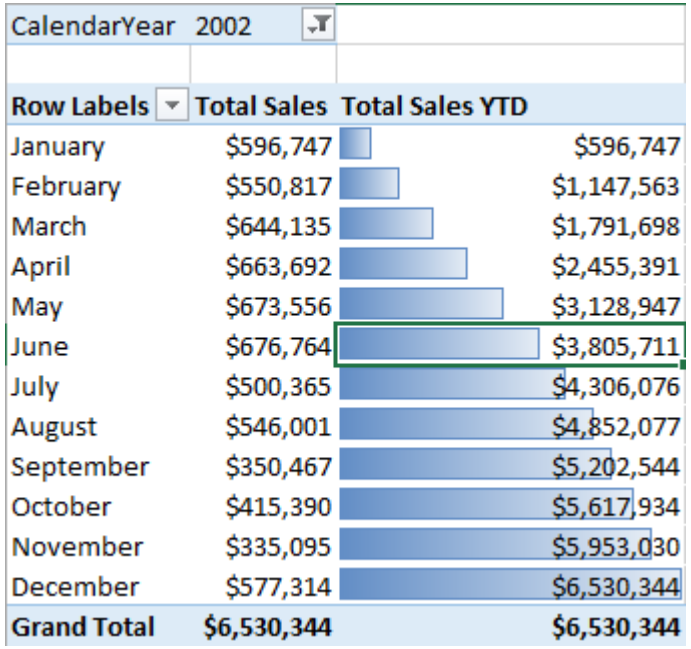
## Rules only apply if you want to use inbuilt Time Intelligence

- Must have a calendar table
- Calendar table must have contiguous date range
  - Don’t skip any days
  - No duplicates
- Good date tables
  - Have all the columns that you will want to use in your filters and formulae.
  - Have numeric sort columns to control the way text is displayed
- Gregorian Calendar only



http://exceleratorbi.com.au/power-pivot-calendar-tables/

# Custom Time Intelligence Pattern



| CalendarYear | 2002 | |
|---|---|---|
| Row Labels | Total Sales | Total Sales YTD |
| January | $596,747 | $596,747 |
| February | $550,817 | $1,147,563 |
| March | $644,135 | $1,791,698 |
| April | $663,692 | $2,455,391 |
| May | $673,556 | $3,128,947 |
| June | $676,764 | $3,805,711 |
| July | $500,365 | $4,306,076 |
| August | $546,001 | $4,852,077 |
| September | $350,467 | $5,202,544 |
| October | $415,390 | $5,617,934 |
| November | $335,095 | $5,953,030 |
| December | $577,314 | $6,530,344 |
| **Grand Total** | **$6,530,344** | **$6,530,344** |

```
Total Sales YTD:= CALCULATE(
        [Total Sales],
        FILTER(
            ALL('Calendar'),
            'Calendar'[Date] <= MAX('Calendar'[Date]) &&
            'Calendar'[Year] = MAX('Calendar'[Year])
        )
    )
```

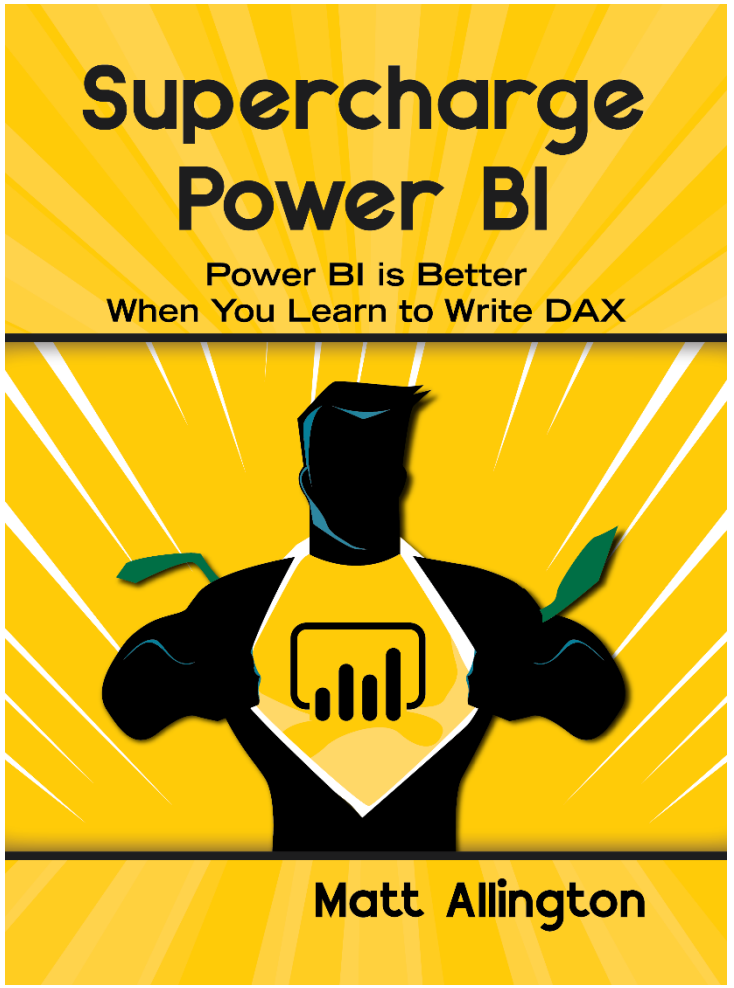
1. You need ALL otherwise you can't access periods that are pre-filtered by the initial filter context
2. Naked Columns mean => apply the filter to this column in the table
3. Aggregators (like MAX) mean => read from the initial filter context

# Some final things

- My presentations from the Microsoft Data Insights Summit are here
  - http://exceleratorbi.com.au/my-mdis-presentations/
- Time Intelligence Blog Article
  - http://exceleratorbi.com.au/dax-time-intelligence-beginners/
  - Download the DAX Quick Guide at the bottom of the page linked above

# Supercharge Power BI Online

# Week 5 Review

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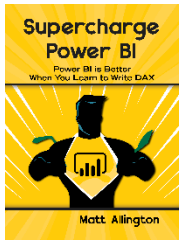
# Week 5 Topics – Supercharge Power BI



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5. Multiple Data Tables, Writing Cube Formulas from scratch, Final questions, Next steps

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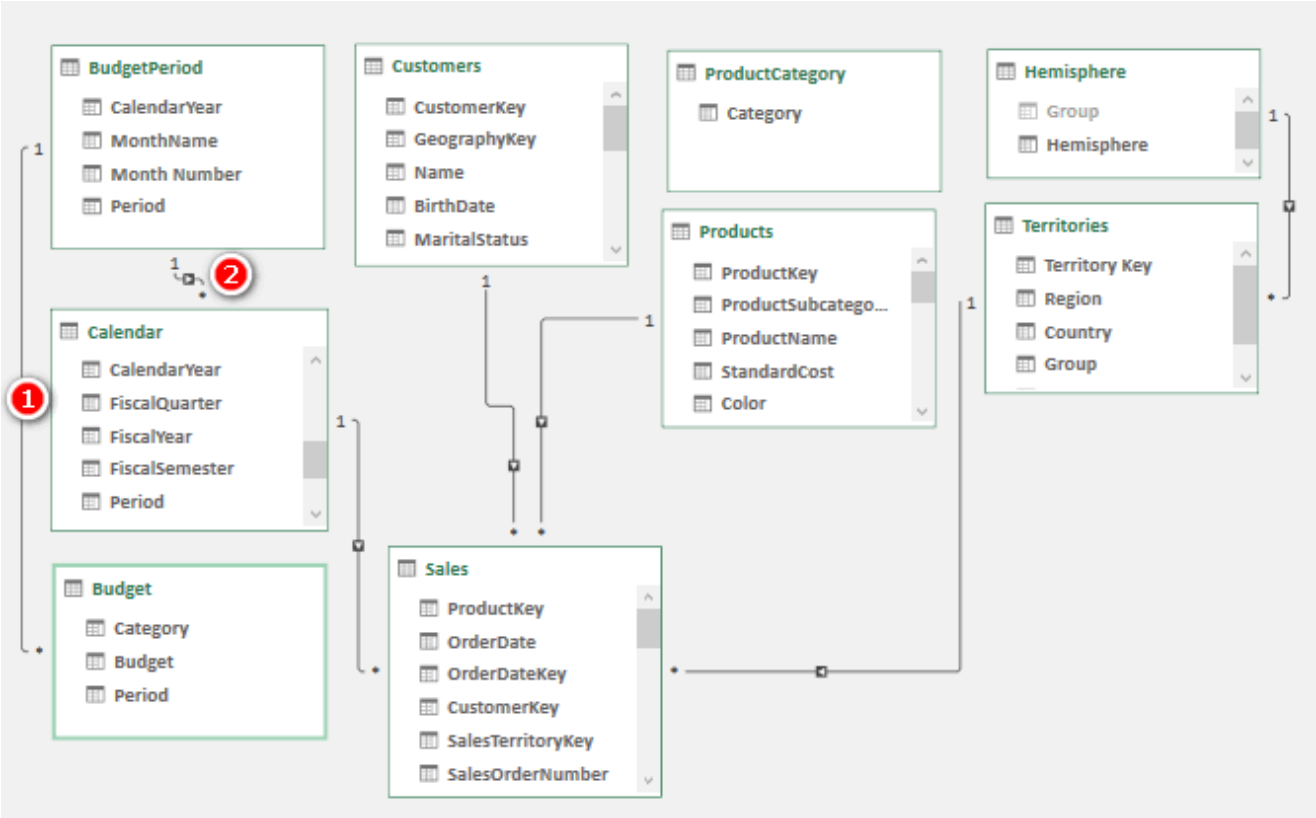
# Multiple Data Tables

- All relationships must be one to many
- Join all data tables to common lookup tables
- You may need new lookup tables to make it all work.

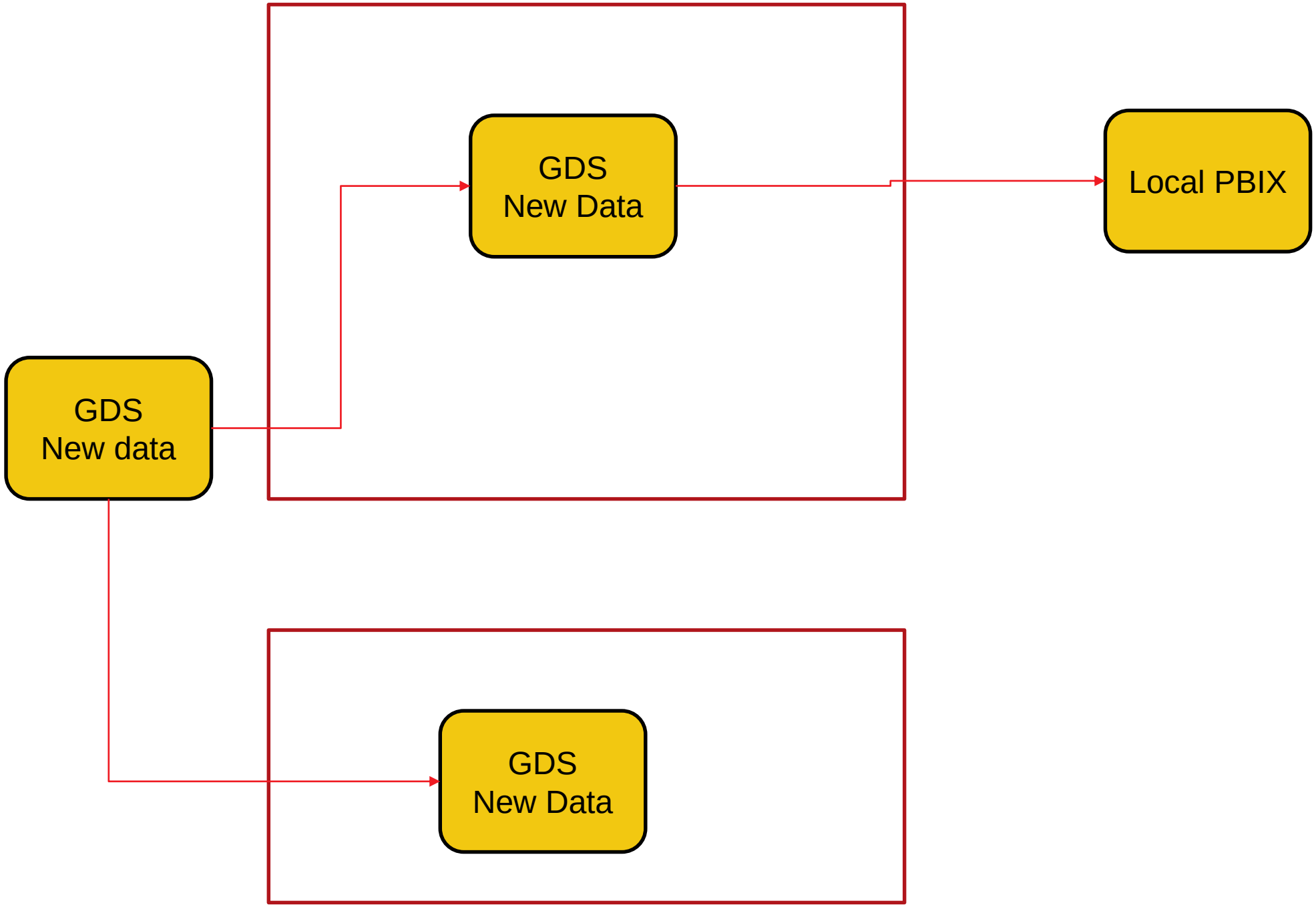


# When Reporting Across Multiple Data Tables

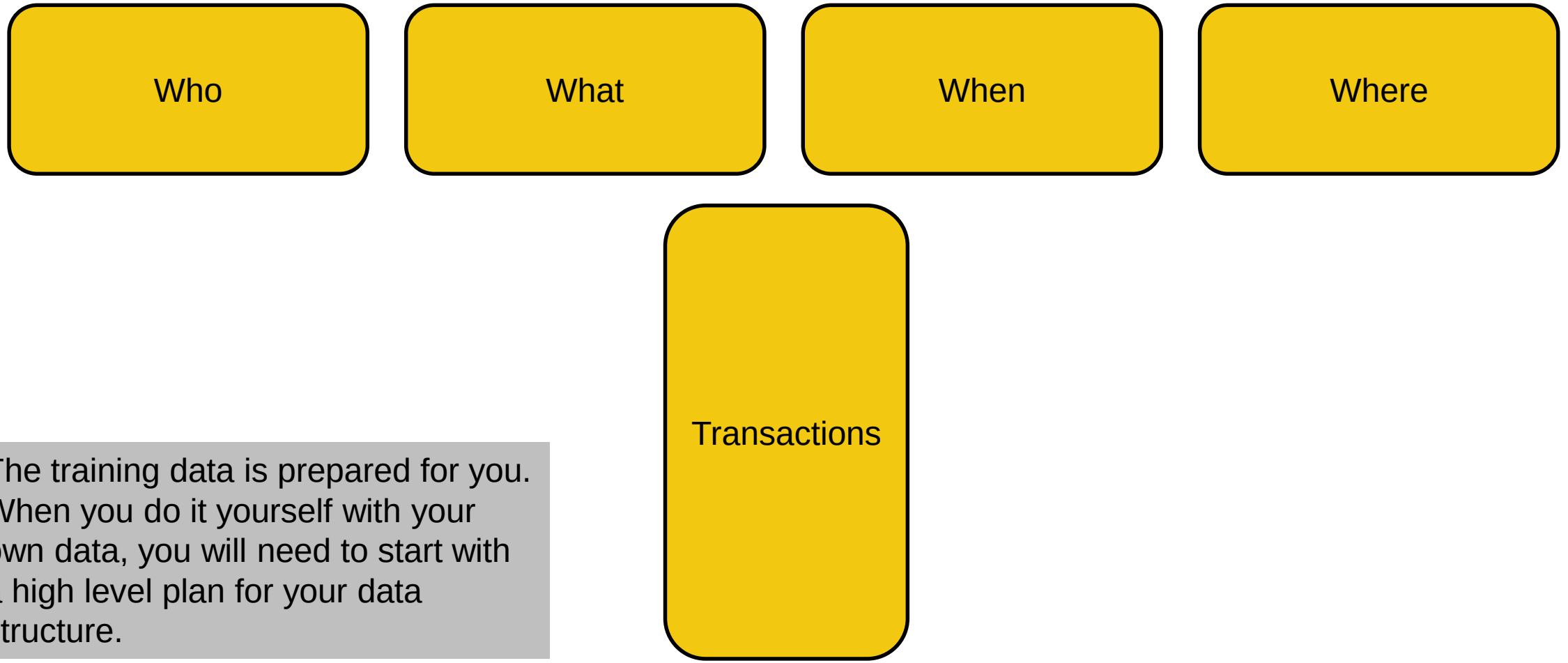
- Always use the common lookup tables in your visuals
- Never use a lookup table that doesn't filter both data tables (directly or indirectly)

# Cube Formulas

- These have always been available, but you must have a “multi dimensional cube” as the data source.
  - Power Pivot and Power BI both have “cubes”
- Used to directly access your measures without using a Pivot Table
- Can be used via
  - Excel Power Pivot
  - Analyze in Excel with PowerBI.com
  - Local Host Workbook


GDS
New Data
Local PBIX
GDS
New data
GDS
New Data

# First Create a High Level Model Plan




The training data is prepared for you. When you do it yourself with your own data, you will need to start with a high level plan for your data structure.

# What next? Use it or lose it!

## Practice

- Re-do the exercises in the book if you are not confident.
- Free

## Read other books

- Free/price of book
- http://exceleratorbi.com.au/recommended-power-reading/

## Subscribe to these blogs

- My blog http://xbi.com.au/blog
- Rob Collie www.powerpivotpro.com
- Ken Puls http://www.excelguru.ca/blog/
- Read and learn incrementally
- free

## Join the Power Pivot Forum

- http://powerpivotforum.com.au
- Free

## Join the Power BI Community

- http://community.powerbi.com/
- https://www.pbiusergroup.com

## Online Training

- Power Query http://xbi.com.au/pqt

**Professional Coaching and Support**

**Matt Allington - Excelerator BI (Microsoft MVP)**

- Help you avoid pitfalls and mistakes that cost you time and effort.
- Contact me at matt@exceleratorbi.com.au

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