

W E L C O M E  
TO *Fabulous*  
TECHORAMA  
A N T W E R P

# Data Modeling 101

Understanding the basics of a good data model

## Unexpected Error

We're sorry. This report ran out of memory, and the application must close.

[Copy details](#)

Send a Frown

Close

**More details** Resource Governing: The query exceeded the maximum memory allowed for queries executed in the current workload group (Requested 1048583KB, Limit 1048576KB).

**Activity ID** 4bd7971d-5a06-496c-a7bb-9c0acfd4abe2

**Correlation ID** 2ed53c67-394a-995a-bad2-a3c72cf2b86d

**Request ID** ffdc7257-8af7-496b-287f-2251260edc03

**Time** Thu Jul 19 2018 16:20:49 GMT+0530 (India Standard Time)

**Version** 13.0.5933.167

**Cluster URI** https://wabi-india-west-redirect.analysis.windows.net

## Unable to save document

Power BI Desktop ran out of memory trying to save the data model

Close

the amount  
provide these details.

## Apply query changes

⚠ Referred Contact

Failed to save modifications to the server. Error returned: 'There's not enough memory to complete this operation. Please try again later when there may be more memory available.'.

Close







# Marc Lelijveld

Data & Analytics consultant  
Macaw Netherlands



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[@MarcLelijveld](https://twitter.com/MarcLelijveld)



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[Data-Marc.com](https://Data-Marc.com)



# After this session you will be able to:



Explain basic dimensional modeling concepts



Create a basic dimensional model that works and performs well with Power BI



Decide when to use Power Query vs the data model and Calculated Columns vs Measures



Handle complex situations with inactive relationships and role-playing dimensions

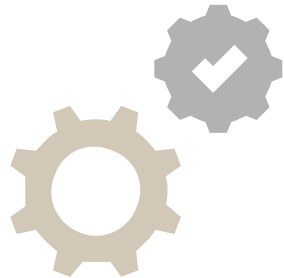


# Set the stage

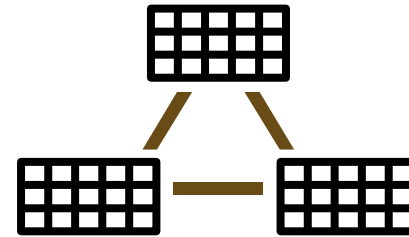
Gather



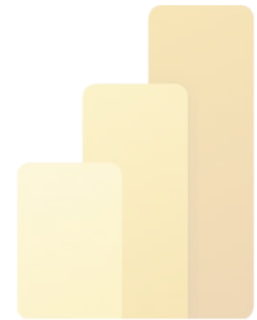
Clean

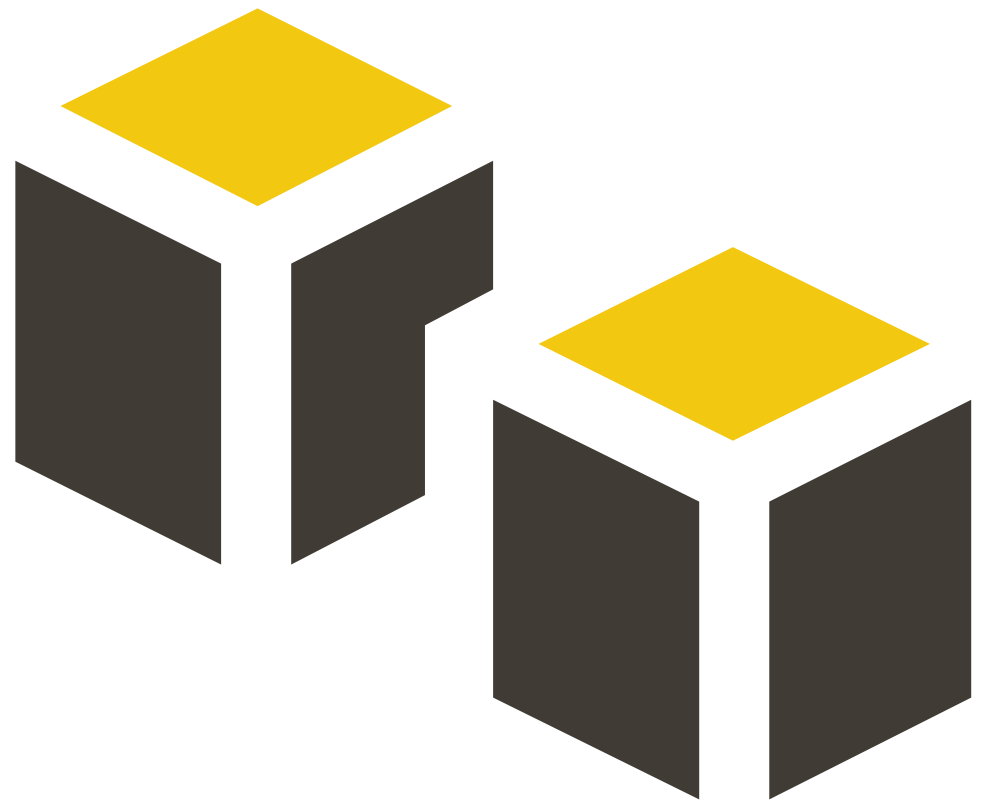


Model



Visualize





---

# Data modeling basics

# What is a data model?

A **Power BI Data Model** is a collection of **tables with relationships** which enable business users to easily understand and explore their data to get business insights.

A good data model is important, because:

- Improves understandability of the data
- Increases performance of dependent processes and systems
- Increases resilience to change

## Why do you need a data model in Power BI?

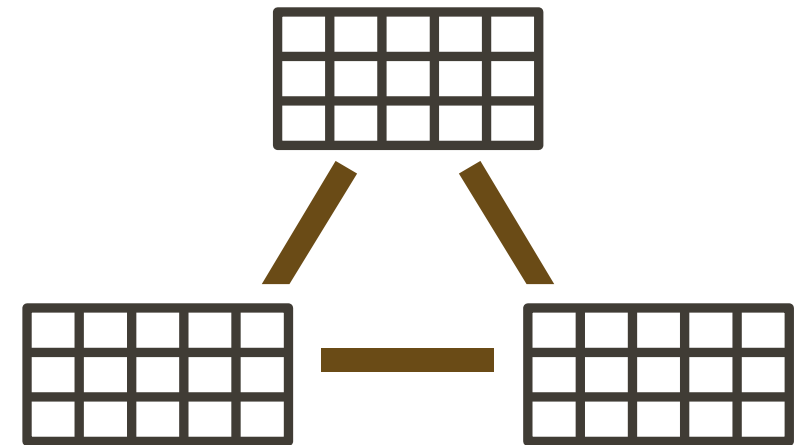
- Easily drag-and-drop visuals
- Re-use of components (when expanding the model)
- Optimize end-user rendering performance

# What is a **good** data model?

A good data model for Power BI is a **dimensional data model**.

A **dimensional data model** consists of:

- One or more fact tables
- One or more dimension tables
- One or more relationships





# Building a dimensional data model

Starting point



**Adventure Works**

TO:  
AW00019377  
Dominic Chandra  
Ingolstadt  
85049 Germany

## INVOICE

INVOICE SO74869  
ORDER DATE: 6/11/2020  
SHIP DATE:

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
1	AWC Logo Cap (CA-1098)	\$8.99	\$8.99
1	Fender Set – Mountain (FE-6654)	\$21.98	\$21.98
1	ML Mountain Tire (TI-M602)	\$29.99	\$29.99
1	Mountain Bottle Cage (BC-M005)	\$9.99	\$9.99
1	Mountain Tire Tube (TT-M928)	\$4.99	\$4.99
1	Sport-100 Helmet, Blue (HL-U509-B)	\$34.99	\$34.99
1	Water Bottle - 30 oz. (WB-H098)	\$4.99	\$4.99
TOTAL DUE			\$115.92

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# Building a dimensional data model

Creating Sales Amount fact



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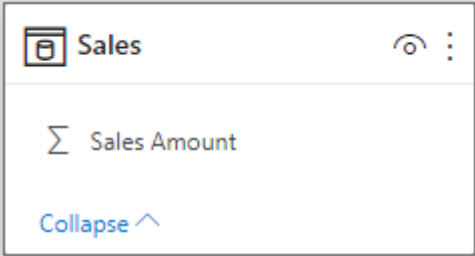
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## Tables

Sales

Sales Amount ▾
\$8.99
\$21.98
\$29.99
\$9.99
\$4.99
\$34.99
\$4.99

## Diagram



# Building a dimensional data model

Adding Order Quantity fact



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Ingolstadt  
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ORDER DATE: 6/11/2020  
SHIP DATE:

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
1	AWC Logo Cap (CA-1098)	\$8.99	\$8.99
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1	Sport-100 <u>Helmet</u> , Blue (HL-U509-B)	\$34.99	\$34.99
1	Water Bottle - 30 oz. (WB-H098)	\$4.99	\$4.99
TOTAL DUE			\$115.92

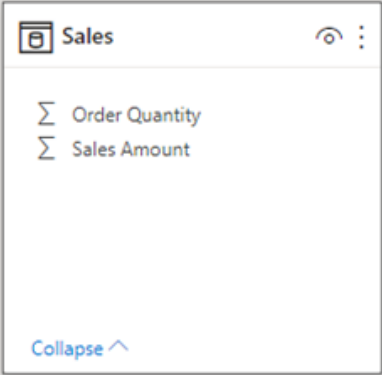
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## Tables

Sales

Sales Amount ▾	Order Quantity ▾
\$8.99	1
\$21.98	1
\$29.99	1
\$9.99	1
\$4.99	1
\$34.99	1
\$4.99	1

## Diagram



# Fact table

Contains **numerical information** about a business process or items to be aggregated

Examples: Sales Amount, Cost, Units Sold, Transactions

Aggregations provide totals, averages, etc.

- Power BI implements these using **Measures**

Usefulness limited without context

- Context is provided by **dimensions** that slice the data


***Without facts there is no aggregation***





# Building a dimensional data model

## Adding Product Dimension table



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SHIP DATE:

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
1	AWC Logo Cap (CA-1098)	\$8.99	\$8.99
1	Fender Set – Mountain (FE-6654)	\$21.98	\$21.98
1	ML Mountain Tire (TI-M602)	\$29.99	\$29.99
1	Mountain Bottle Cage (BC-M005)	\$9.99	\$9.99
1	Mountain Tire Tube (TT-M928)	\$4.99	\$4.99
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## Tables

Product

SKU	Product
CA-1098	AWC Logo Cap
FE-6654	Fender Set - Mountain
TI-M602	ML Mountain Tire
BC-M005	Mountain Bottle Cage
TT-M928	Mountain Tire Tube
HL-U509-B	Sport-100, Helmet, Blue
WB-H098	Water Bottle - 30 oz.

Sales

Sales Amount	Order Quantity
\$8.99	1
\$21.98	1
\$29.99	1
\$9.99	1
\$4.99	1
\$34.99	1
\$4.99	1

## Diagram

Product

Product

SKU

Collapse

Sales

Order Quantity

Sales Amount

Collapse

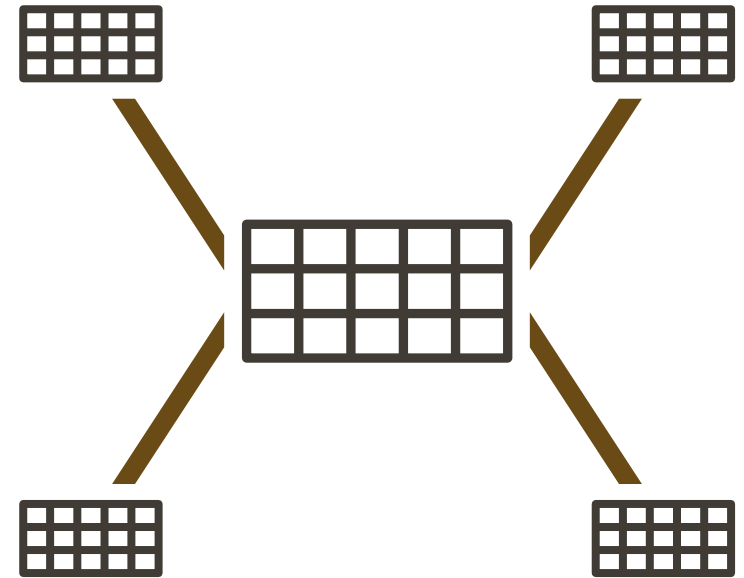
# Dimension table

Contains **descriptive information** that define how a fact should roll up.

Examples: Date, Month, Customer, Geography, Product, Payment type.

Without dimensions there is no context.

Also called: Lookup table on steroids.



# Building a dimensional data model

Adding Product attribute to fact table



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QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
1	AWC Logo Cap (CA-1098)	\$8.99	\$8.99
1	Fender Set – Mountain (FE-6654)	\$21.98	\$21.98
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## Tables

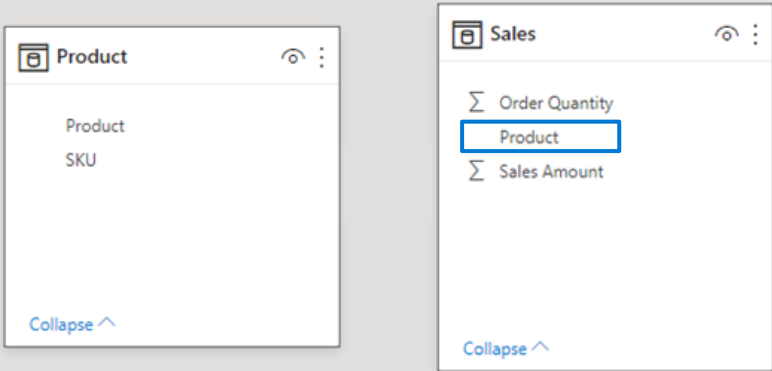
Product

SKU	Product
CA-1098	AWC Logo Cap
FE-6654	Fender Set - Mountain
TI-M602	ML Mountain Tire
BC-M005	Mountain Bottle Cage
TT-M928	Mountain Tire Tube
HL-U509-B	Sport-100, Helmet, Blue
WB-H098	Water Bottle - 30 oz.

Sales


Sales Amount	Order Quantity	Product
\$8.99	1	CA-1098
\$21.98	1	FE-6654
\$29.99	1	TI-M602
\$9.99	1	BC-M005
\$4.99	1	TT-M928
\$34.99	1	HL-U509-B
\$4.99	1	WB-H098

## Diagram



# Building a dimensional data model

Adding Sales Order and Order Date attribute to fact



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SHIP DATE:

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
1	AWC Logo Cap (CA-1098)	\$8.99	\$8.99
1	Fender Set – Mountain (FE-6654)	\$21.98	\$21.98
1	ML Mountain Tire (TI-M602)	\$29.99	\$29.99
1	Mountain Bottle Cage (BC-M005)	\$9.99	\$9.99
1	Mountain Tire Tube (TT-M928)	\$4.99	\$4.99
1	Sport-100 <u>Helmet</u> , Blue (HL-U509-B)	\$34.99	\$34.99
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TOTAL DUE			\$115.92

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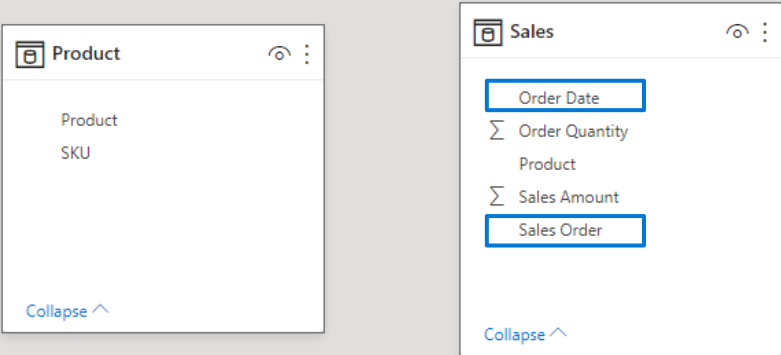
## Tables

Sales

Sales Amount	Order Quantity	Product	Sales Order	Order Date
\$8.99	1	CA-1098	SO74869	6/11/2020
\$21.98	1	FE-6654	SO74869	6/11/2020
\$29.99	1	TI-M602	SO74869	6/11/2020
\$9.99	1	BC-M005	SO74869	6/11/2020
\$4.99	1	TT-M928	SO74869	6/11/2020
\$34.99	1	HL-U509-B	SO74869	6/11/2020
\$4.99	1	WB-H098	SO74869	6/11/2020
\$8.99	2	CA-1098	SO74870	7/11/2020

Product


## Diagram





# Building a dimensional data model

Adding relationship between Product and Sales



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ORDER DATE: 6/11/2020  
SHIP DATE:

TO:

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Dominic Chandra  
Ingolstadt  
85049 Germany

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
1	AWC Logo Cap (CA-1098)	\$8.99	\$8.99
1	Fender Set – Mountain (FE-6654)	\$21.98	\$21.98
1	ML Mountain Tire (TI-M602)	\$29.99	\$29.99
1	Mountain Bottle Cage (BC-M005)	\$9.99	\$9.99
1	Mountain Tire Tube (TT-M928)	\$4.99	\$4.99
1	Sport-100 <u>Helmet</u> , Blue (HL-U509-B)	\$34.99	\$34.99
1	Water Bottle - 30 oz. (WB-H098)	\$4.99	\$4.99
TOTAL DUE			\$115.92

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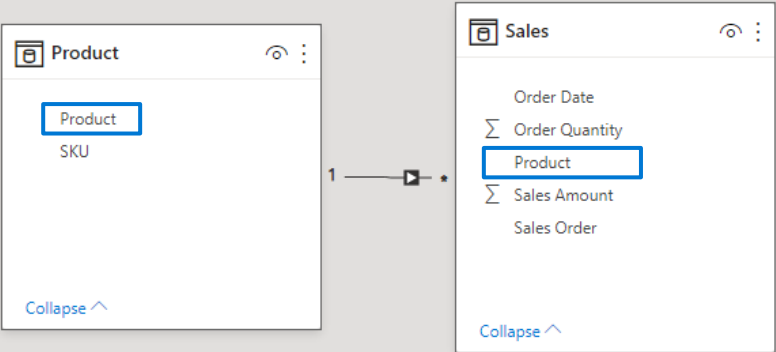
## Tables

Sales

Sales Amount	Order Quantity	Product	Sales Order	Order Date
\$8.99	1	CA-1098	SO74869	6/11/2020
\$21.98	1	FE-6654	SO74869	6/11/2020
\$29.99	1	TI-M602	SO74869	6/11/2020
\$9.99	1	BC-M005	SO74869	6/11/2020
\$4.99	1	TT-M928	SO74869	6/11/2020
\$34.99	1	HL-U509-B	SO74869	6/11/2020
\$4.99	1	WB-H098	SO74869	6/11/2020
\$8.99	2	CA-1098	SO74870	7/11/2020

Product

## Diagram





# Relationships

# Relationship

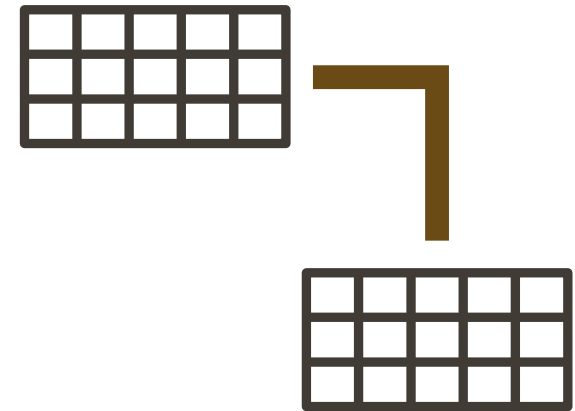
Connection between two tables using columns from each.

Usually between fact and dimension or dimension and dimension.

***Without relationships there is no slicing.***

Three kinds:

- One-to-many (1:M)
- One-to-one (1:1)
- Many-to-many (M:N)



# Relationship types

## 1 to 1

Every **individual record** in dataset A is mapped to one **individual record** in dataset B

**Dataset A**  
Customer information

Customer ID	Country
AW000111024	United States
AW00019377	Germany

**Dataset B**  
Customer information

Customer ID	Date of Birth
AW000111024	9 april 1990
AW00019377	9 april 1983

## 1 to many

**One record** of dataset A is mapped to **multiple records** in dataset B

**Dataset A**  
Customer information

Customer ID	Country
AW000111024	United States
AW00019377	Germany

**Dataset B**  
Sales Information

Customer ID	Product	Order Quantity
AW00011024	CA-1098	2
AW00019377	BC-M005	1
AW00019377	CA-1098	1
AW00019377	FE-6654	1
AW00019377	HL-U509-8	1
AW00019377	TI-M602	1
AW00019377	TT-M928	1
AW00019377	WB-H098	1

## Many to many

**Multiple records** of dataset A are mapped to **multiple records** in dataset B

**Dataset A**  
Customer information

Customer ID	Store ID	Store Type
AW00011024	ON-1	Online
AW00011024	ST-1	Regional City Store
AW00011024	ST-2	Regional City Store
AW00019377	ON-1	Online
AW00019377	ST-1	Regional City Store
AW00019377	ST-2	Regional City Store


**Dataset B**  
Sales Information

Customer ID	Product	Order Quantity
AW00011024	CA-1098	2
AW00011024	TT-M928	5
AW00019377	BC-M005	1
AW00019377	CA-1098	1
AW00019377	FE-6654	1
AW00019377	HL-U509-8	1
AW00019377	TI-M602	1
AW00019377	TT-M928	1
AW00019377	WB-H098	1



# Building a dimensional data model

Adding customer dimension



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85049 Germany

INVOICE

INVOICE S074869  
ORDER DATE: 6/11/2020  
SHIP DATE:

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
1	AWC Logo Cap (CA-1098)	\$8.99	\$8.99
1	Fender Set – Mountain (FE-6654)	\$21.98	\$21.98
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1	Mountain Bottle Cage (BC-M005)	\$9.99	\$9.99
1	Mountain Tire Tube (TT-M928)	\$4.99	\$4.99
1	Sport-100 <u>Helmet</u> , Blue (HL-U509-B)	\$34.99	\$34.99
1	Water Bottle - 30 oz. (WB-H098)	\$4.99	\$4.99
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## Tables

Customer

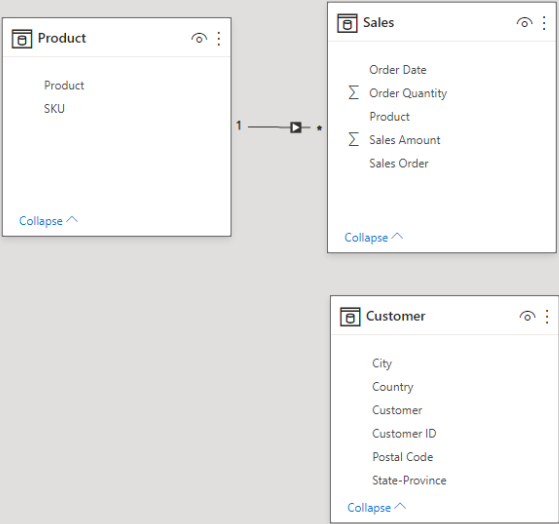
Customer ID	Customer	City	Postal Code	Country	State-Province
AW00019377	Dominic Chandra	Ingolstadt	85049	Germany	Bayern

Sales

Sales Amount	Order Quantity	Product	Sales Order	Order Date
\$8.99	1	CA-1098	S074869	6/11/2020
\$21.98	1	FE-6654	S074869	6/11/2020
\$29.99	1	TI-M602	S074869	6/11/2020
\$9.99	1	BC-M005	S074869	6/11/2020
\$4.99	1	TT-M928	S074869	6/11/2020
\$34.99	1	HL-U509-B	S074869	6/11/2020
\$4.99	1	WB-H098	S074869	6/11/2020
\$8.99	2	CA-1098	S074870	7/11/2020


Product

## Diagram



# Building a dimensional data model

Adding customer attribute on fact and relationship



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INVOICE S074869  
ORDER DATE: 6/11/2020  
SHIP DATE:

TO:  
AW00019377  
Dominic Chandra  
Ingolstadt  
85049 Germany

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
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## Tables

Customer

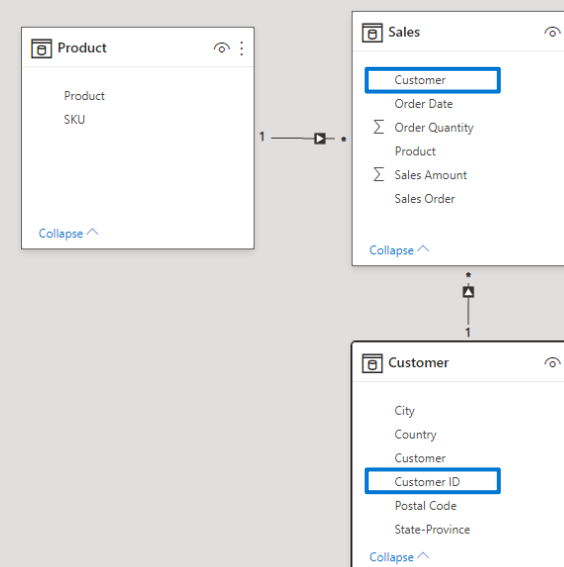
Customer ID	Customer	City	Postal Code	Country	State-Province
AW00019377	Dominic Chandra	Ingolstadt	85049	Germany	Bayern

Sales

Sales Amount	Order Quantity	Product	Sales Order	Order Date
\$8.99	1	CA-1098	S074869	6/11/2020
\$21.98	1	FE-6654	S074869	6/11/2020
\$29.99	1	TI-M602	S074869	6/11/2020
\$9.99	1	BC-M005	S074869	6/11/2020
\$4.99	1	TT-M928	S074869	6/11/2020
\$34.99	1	HL-U509-B	S074869	6/11/2020
\$4.99	1	WB-H098	S074869	6/11/2020
\$8.99	2	CA-1098	S074870	7/11/2020


Product

## Diagram



# Building a dimensional data model

Adding Date dimension and relationship



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Dominic Chandra  
Ingolstadt  
85049 Germany

INVOICE

INVOICE S074869  
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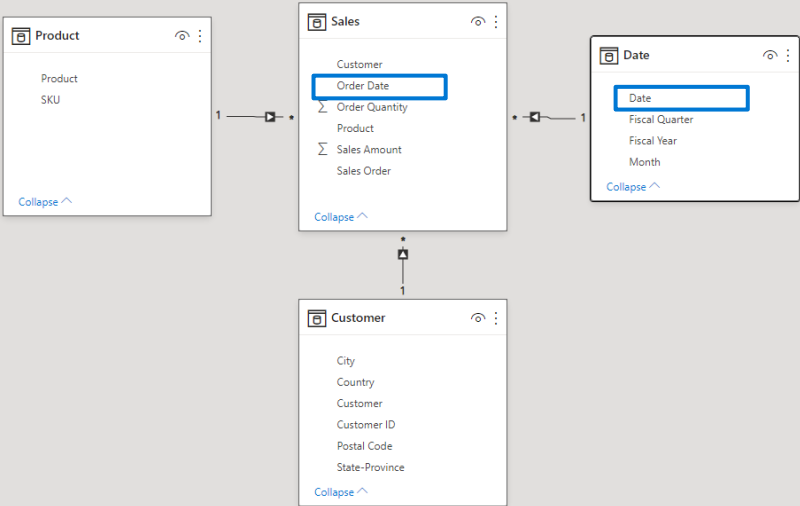
## Tables

Date

Date	Fiscal Quarter	Fiscal Year	Month
6/11/2020	FY2020 Q4	FY2020	2020 Jun
7/11/2020	FY2021 Q1	FY2021	2021 July


Product Customer Sales

## Diagram



# Building a dimensional data model

Adding Ship Date attribute and relationship



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Ingolstadt  
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INVOICE

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1	ML Mountain Tire (TI-M602)	\$29.99	\$29.99
1	Mountain Bottle Cage (BC-M005)	\$9.99	\$9.99
1	Mountain Tire Tube (TT-M928)	\$4.99	\$4.99
1	Sport-100 <u>Helmet</u> , Blue (HL-U509-B)	\$34.99	\$34.99
1	Water Bottle - 30 oz. (WB-H098)	\$4.99	\$4.99
TOTAL DUE			\$115.92

Make all checks payable to Adventure Works.  
If you have any questions concerning this invoice, contact: info@adventureworks.com

THANK YOU FOR YOUR BUSINESS!

## Tables

Date

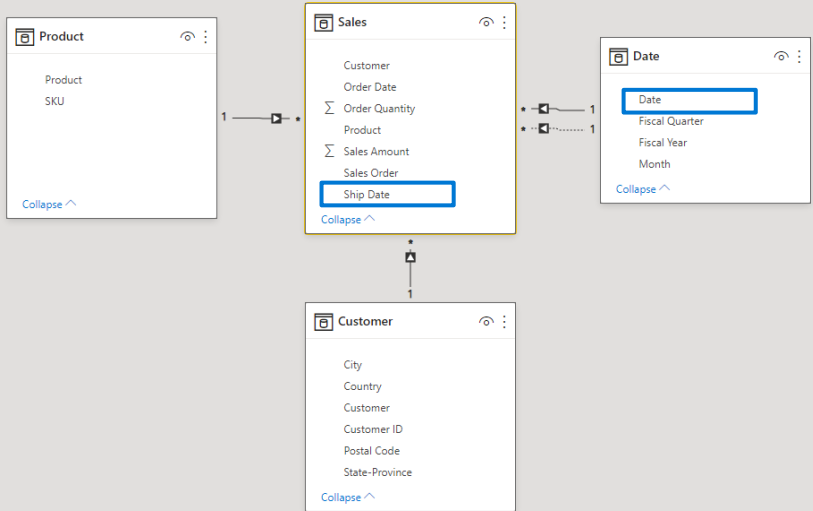
Date	Fiscal Quarter	Fiscal Year	Month
6/11/2020	FY2020 Q4	FY2020	2020 Jun
7/11/2020	FY2021 Q1	FY2021	2021 July

Product

Customer

Sales

## Diagram





# Role playing dimension

**Role playing dimension: same dimension being used multiple times**

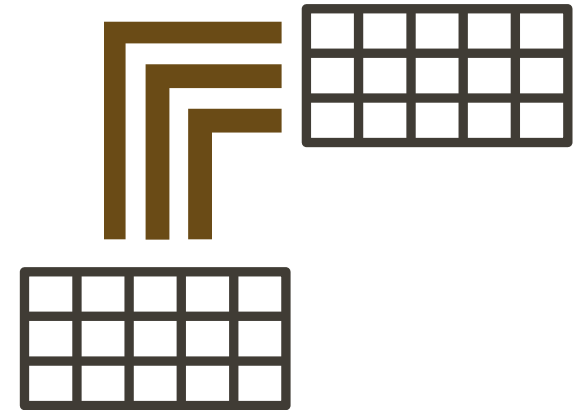
**Example:** Date dimension (OrderDate, ShipDate)

**In Power BI: one active relationship between two tables**

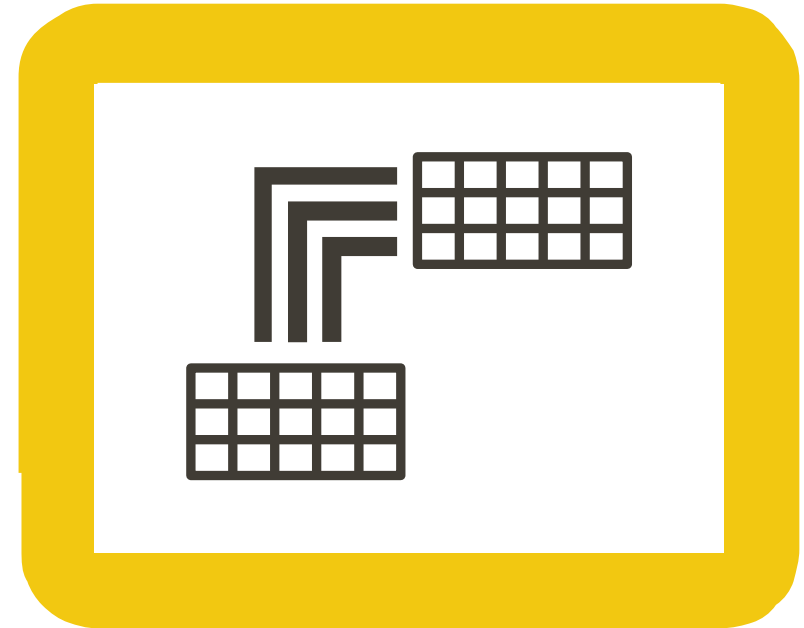
- Any other will be inactive
- USERELATIONSHIP()

**Auto date/time**

- Auto date/time creates a date table for each date that is not used in a relationship
- Might be worth it to introduce your own date dimension

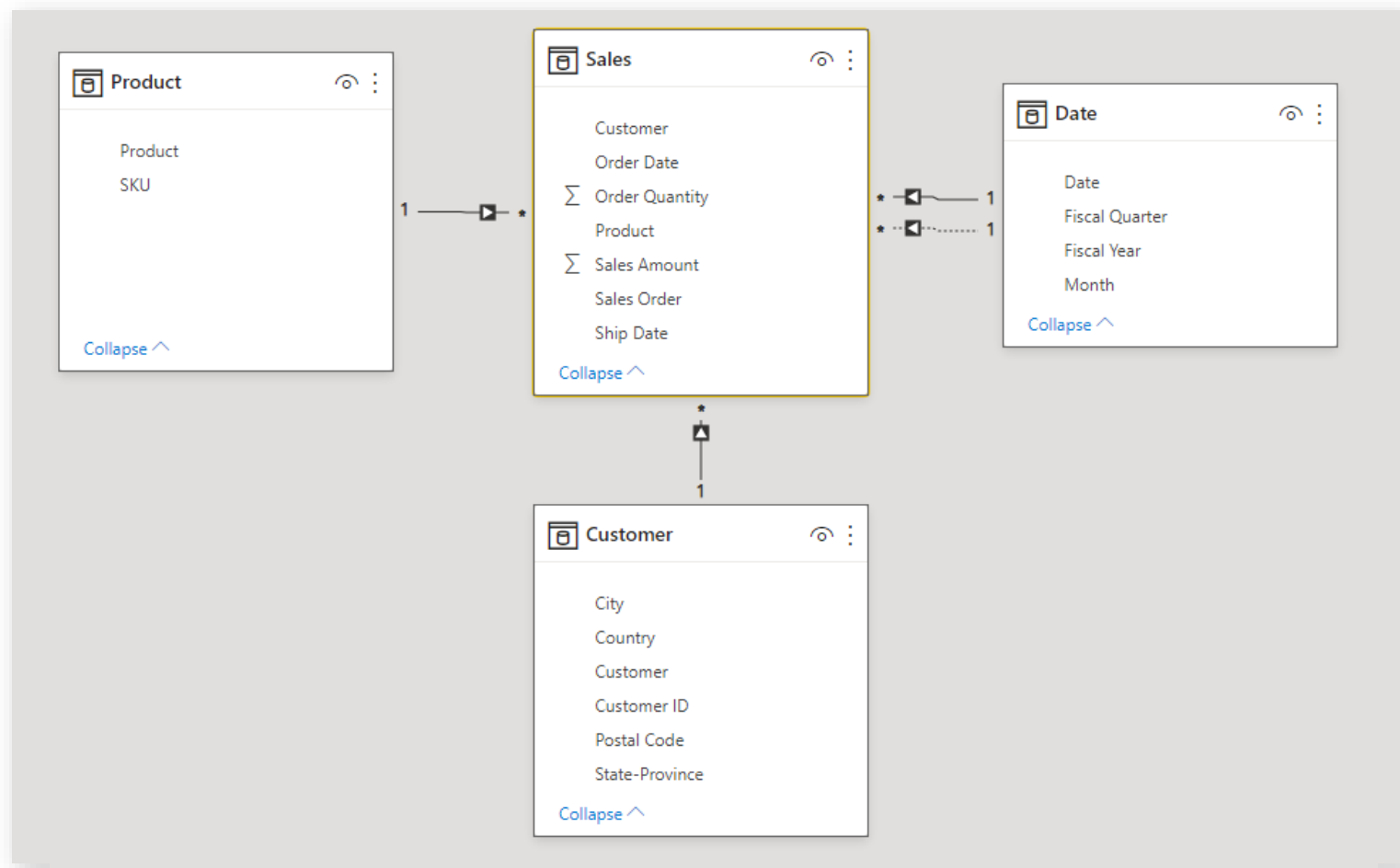


## Role-playing dimensions



# Building a dimensional data model

Final model

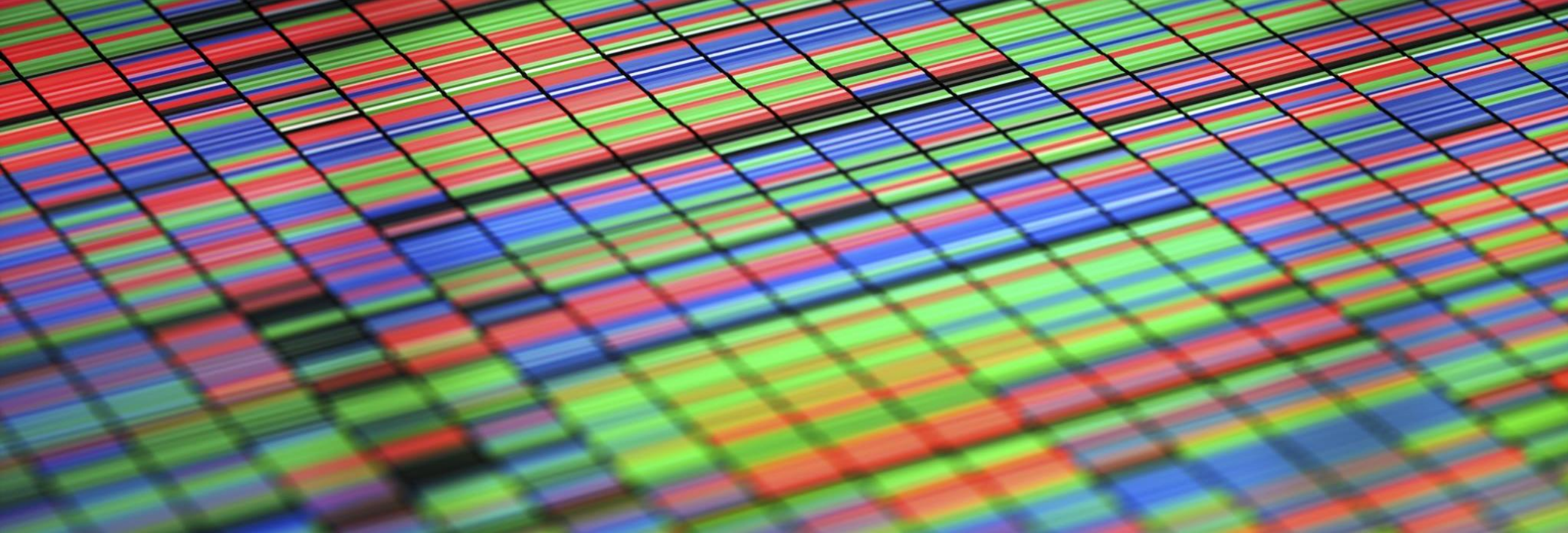


# Note

## **This is a simplified, imperfect data model:**

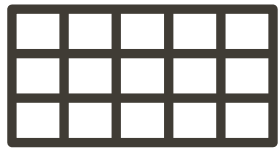
- Keys should be numerical instead of strings (surrogate keys)
- Sales Order should be separate dimension since the fact is on Sales Order Line, not Sales Order.



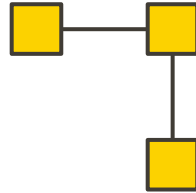


# Data model types

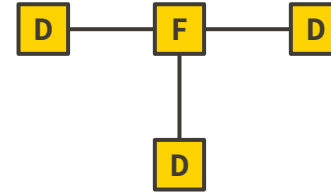
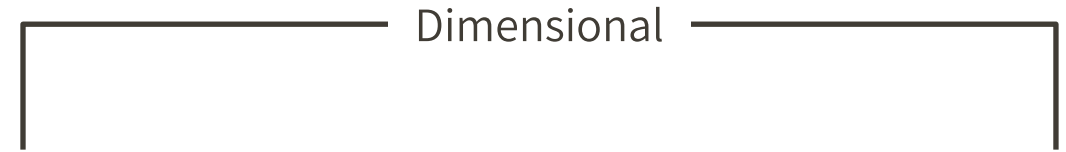
# Major types of data models



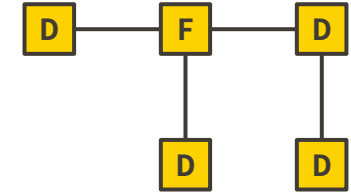
Flat



Normalized  
(n<sup>th</sup> normal form)








Star



Snowflake

# Different data model types

	Flat table	Normalized	Star schema	Snowflake
 Performance for analytics	Low	Medium	High	High
 Development effort	Low	High	High	High
 Query volume and complexity	Low volume Low complexity	High volume Low complexity	Low volume High complexity	Low volume High complexity
 Intended for	No database	CRM / ERP / Applications	Analytical systems / data warehouses	Analytical systems / data warehouses
 Compression	Row	Row	Column	Column



# Considerations for data modeling in Power BI

Do data cleansing activity in one place.

- Data platform
- Database views
- Power Query

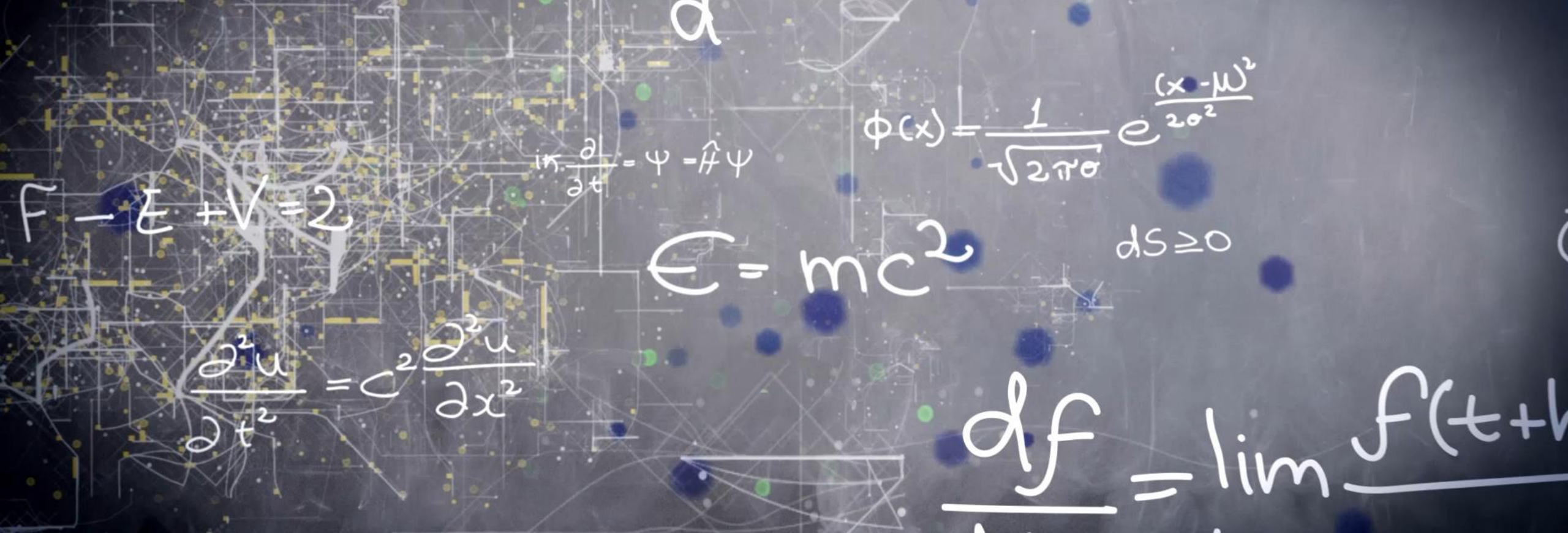
Enrich your data with measures and calculated columns.



# Roche's Maxim of Data Transformation

***"Data should be transformed as far upstream as possible, and as far downstream as necessary."***

***Matthew Roche***



## Calculations

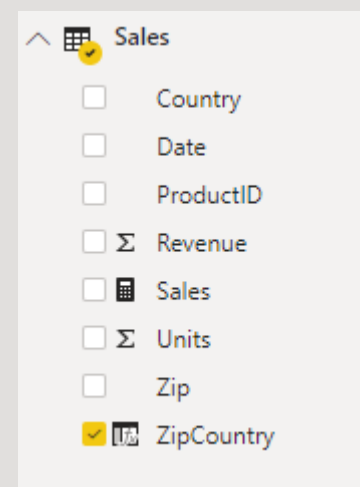
# Calculated Column

To create a calculated column using a DAX formula, select the **New column** button from the **Modeling** tab.

**A calculated column:**

- Is useful for slicing or filtering a value, or for doing a calculation on every row in the table
- Saves its result in the data model
- Evaluates while reloading the data model, not while executing the query
- Consumes **memory**! (increases model size)
- Evaluates per row

```
DiscountCategory =  
IF(  
    Sales[DiscountPct] = 0; "FULL PRICE";  
    IF(Sales[DiscountPct] <= 0,05; "LOW";  
        IF(Sales[DiscountPct] <= 0,1; "MEDIUM"; "HIGH")))
```

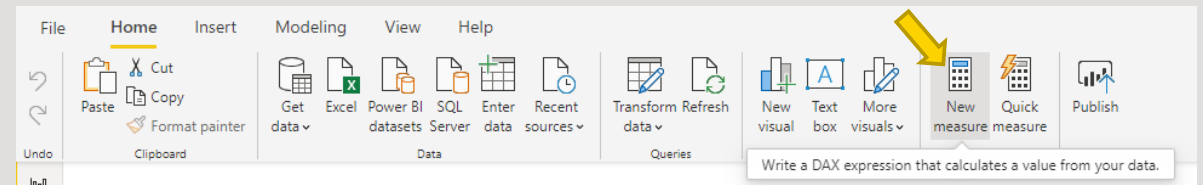
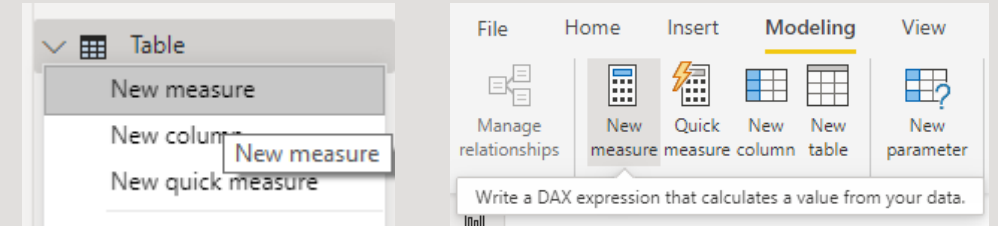


# Measure

To create a measure using a DAX formula, select the **New measure** button from the **Modeling** tab.

**A measure:**

- Aggregates a column
- Evaluates a total, not row-per-row
- Evaluates while executing the query
- Costs **CPU-power** instead of memory
- Always has one answer



# Calculated column vs Measure

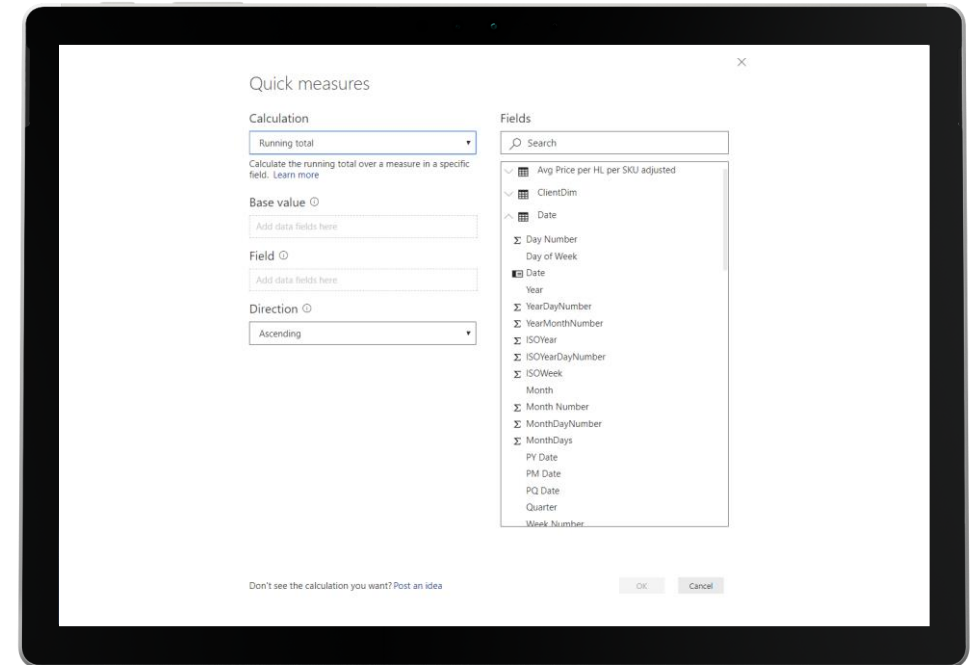
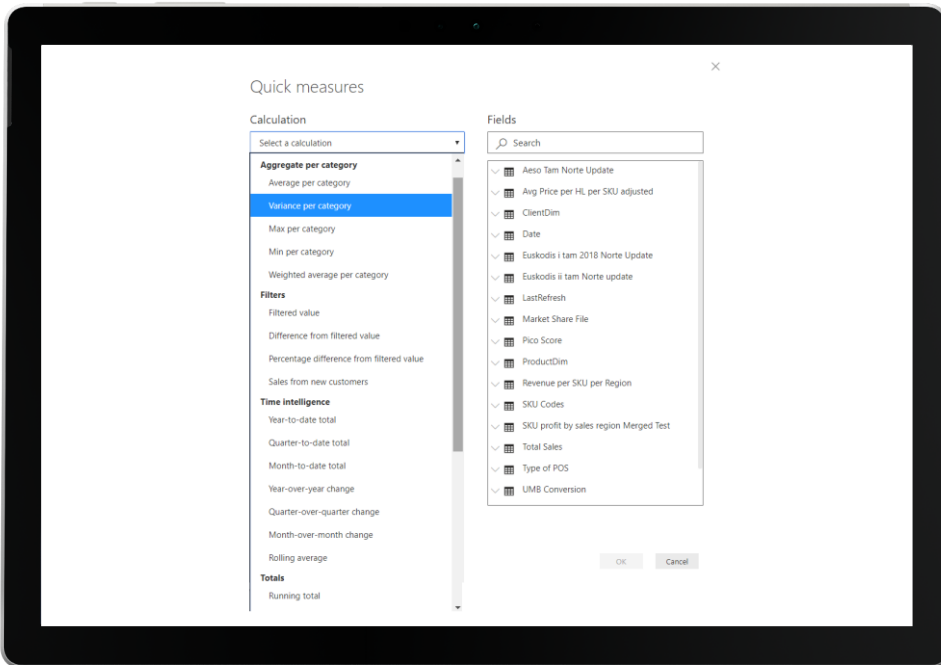
	Calculated Column	Measure
Persistence	Definition and result saved in data model	Definition saved in data model, result is calculated when a visual is created
Usage	Can be used on slicers, filters, rows, columns, etc.	Can only be used as a value in a visual and visual level filters
Language	DAX / M (Power Query)	DAX
Scope	Single row	Set of rows / table
Calculation happens	On data refresh	On demand when a visual is created
Effect	Blows up data model	Increases report performance (compared to calculated column)

ProductID	Date	CustomerID	CampaignID	Units	Sales Amount
449	7/29/14	128304	1	1	\$102.37
449	7/29/14	89917	1	1	\$102.37
449	7/29/14	128811	1	1	\$102.37
449	7/29/14	59550	1	1	\$102.37
449	7/29/14	207690	1	1	\$102.37
449	7/29/14	121043	1	1	\$102.37
449	7/29/14	148675	1	1	\$102.37
449	7/29/14	65048	1	1	\$102.37



# Quick measures

You can make many difficult DAX calculations without code, **just drag and drop**.





# Measures and Calculated Columns



# Rules to live by



DAX complexity down,  
Performance up



Simple DAX is a sign of  
a good data model

# Key take-aways

- Do data transformation as close to the source as possible. In Power BI: use the “Transform Data” options.
- Use a star schema or snowflake data model to get the best out of Power BI.
- Consider auto date/time vs creating a Date dimension
- Use a role-playing dimension instead of adding the same dimension multiple times.
  - Most common example: Date



# Resources

## **Learning path: Model data in Power BI:**

<https://docs.microsoft.com/en-us/learn/paths/model-power-bi/>

## **Learning path: Use DAX in Power BI Desktop:**

<https://aka.ms/DAXLearningPath>

## **Guidance: Auto date/time in Power BI desktop:**

<https://docs.microsoft.com/en-us/power-bi/transform-model/desktop-auto-date-time>

## **Quick measure gallery:**

<https://community.powerbi.com/t5/Quick-Measures-Gallery/bd-p/QuickMeasuresGallery>

## **DAX Expression: USERELATIONSHIP:**

<https://docs.microsoft.com/en-us/dax/userelationship-function-dax>

## **AdventureWorks 2020 demo dataset:**

<https://github.com/microsoft/powerbi-desktop-samples/tree/master/DAX>



# Want to review all this content?

LET'S  
RECAP...

Webinar Series: Mastering Data Modeling with Power BI

Episode 1 - Data Modeling 101: Increasing the Impact of Power BI

by Jeroen ter Heerdt and Marc Lelijveld

[Watch now](#)

Webinar Series: Mastering Data Modeling with Power BI Episode 2 - Learn Advanced Data Modeling with Power BI

by Jeroen ter Heerdt and Marc Lelijveld

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Webinar Series: Mastering Data Modeling with Power BI

Episode 3 - Data Modeling for Experts with Power BI

by Jeroen ter Heerdt and Marc Lelijveld

[Register to watch on September 8th, 2021 10AM – 11AM Pacific Time](#)

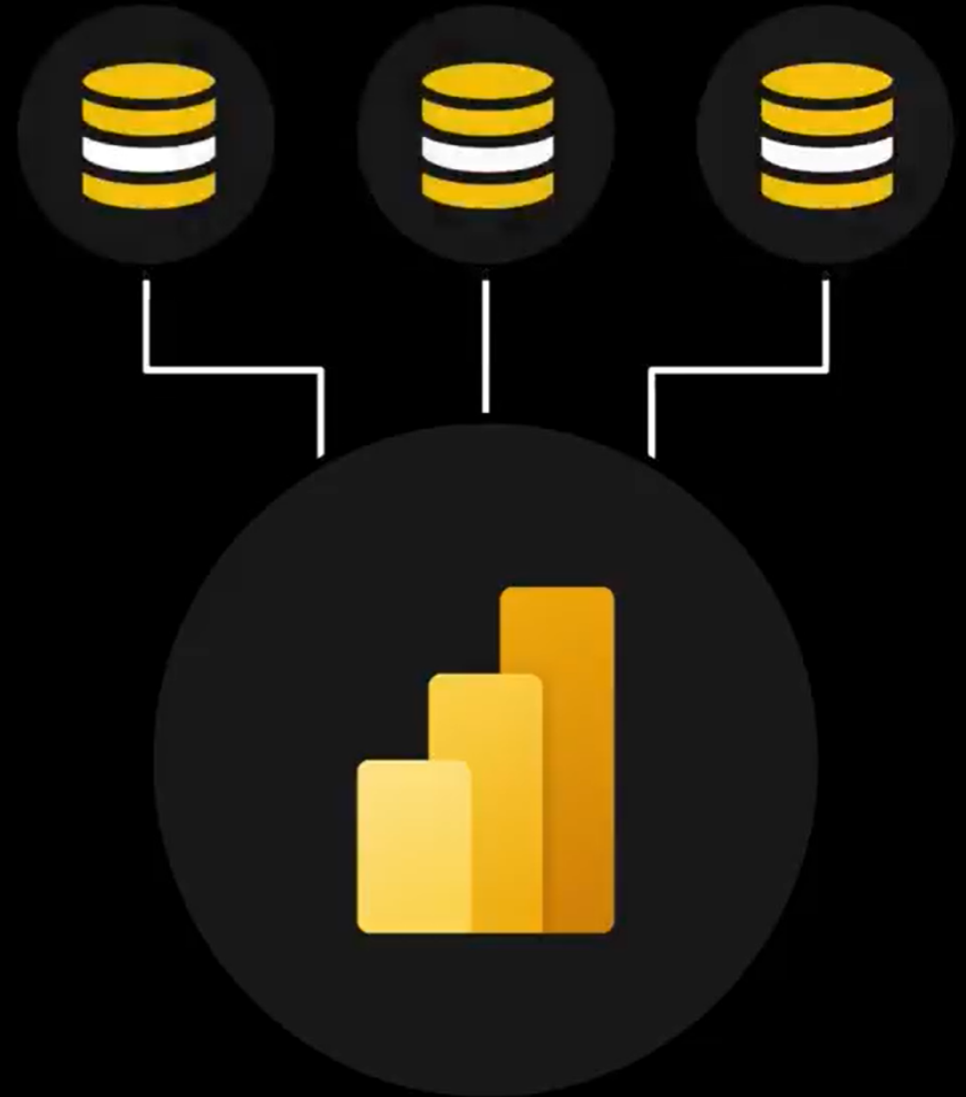
**Find them all here:** <https://docs.microsoft.com/en-us/power-bi/fundamentals/webinars>  
**or:** [aka.ms/DataModelingWebinarEpisode{1/2/3}](https://aka.ms/DataModelingWebinarEpisode{1/2/3})

## Webinar

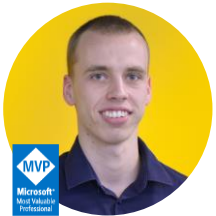
# Data Modeling with Power BI: Calculation groups & Composite models

## Power BI

<https://info.microsoft.com/ww-landing-calculation-groups-and-composite-models>



# Thanks for attending!



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Macaw Netherlands

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