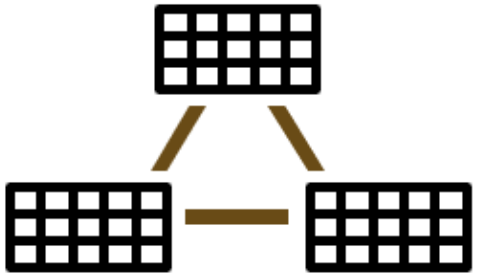
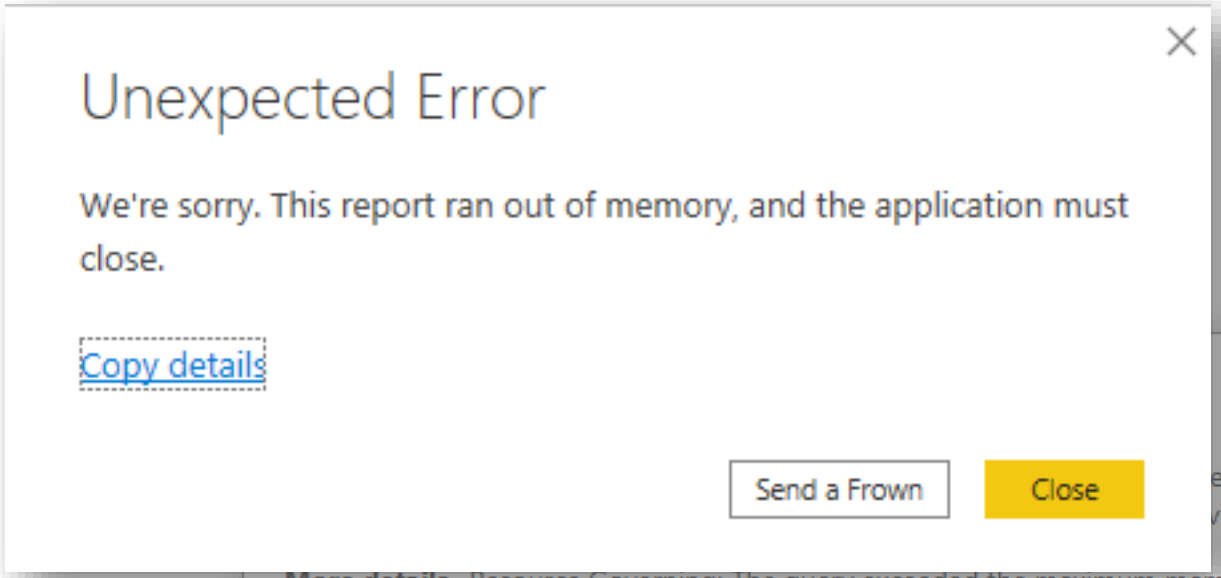
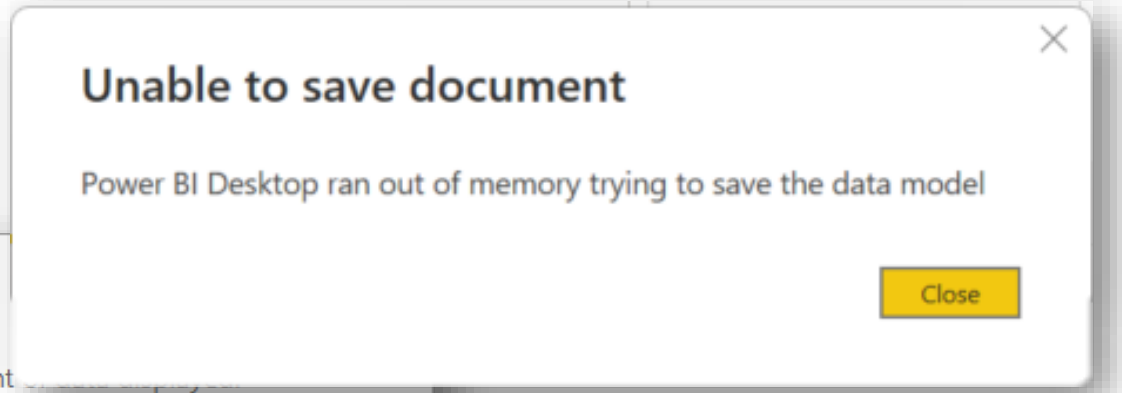
Gather Clean **Model** Visualize



Data Modeling 101

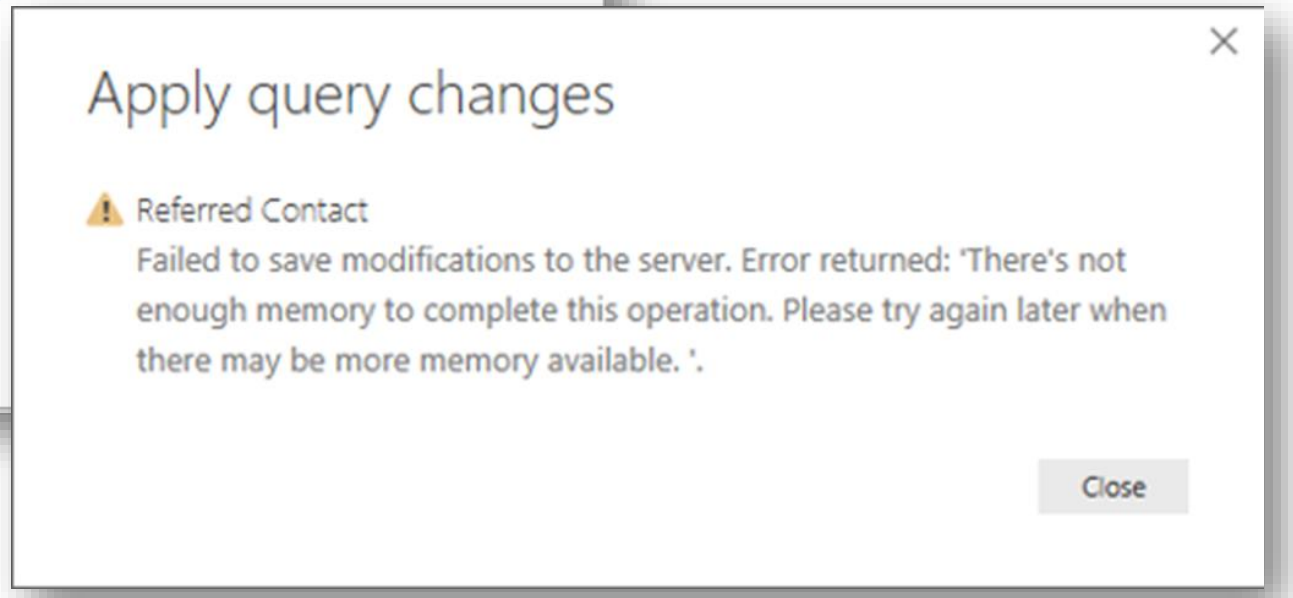
Understanding the basics of a good data model





e amount
vide these details.

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



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Marc Lelijveld

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Macaw Netherlands

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Microsoft Power Platform
FASTTRACK RECOGNIZED SOLUTION ARCHITECT
2023

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Microsoft MCT

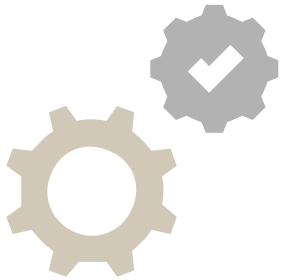
After this session you will be able to:

- 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

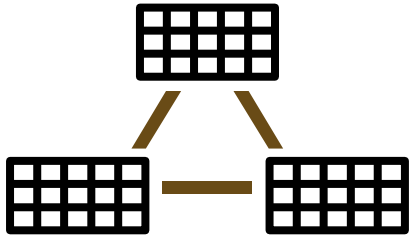
Set the stage

Gather

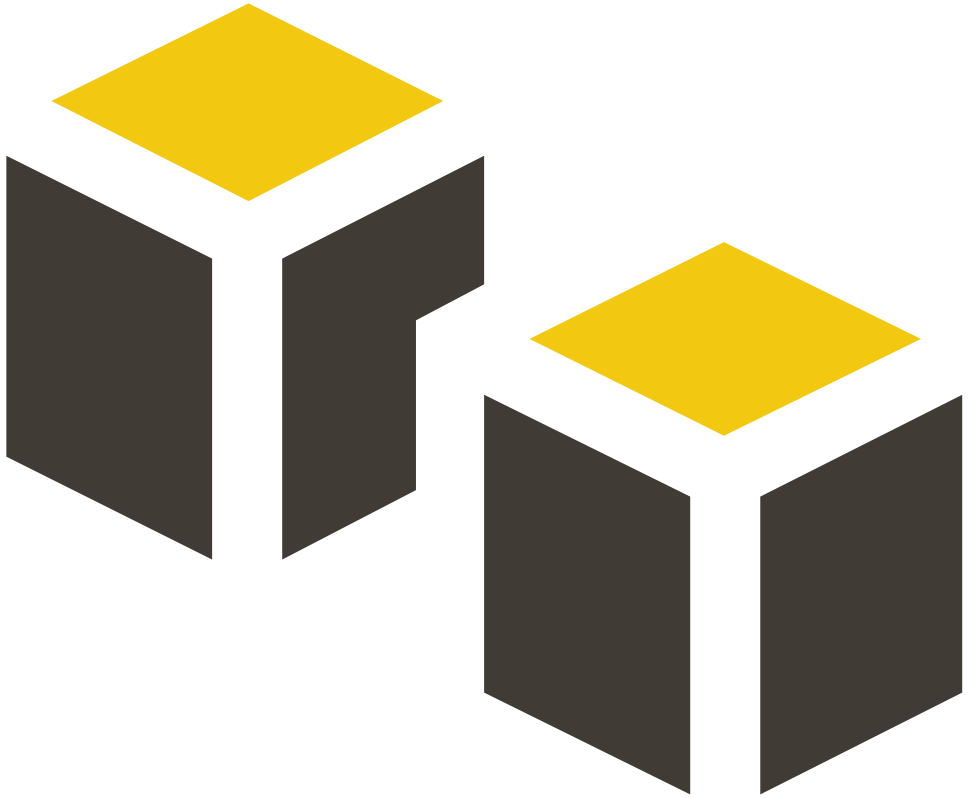
Clean



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?

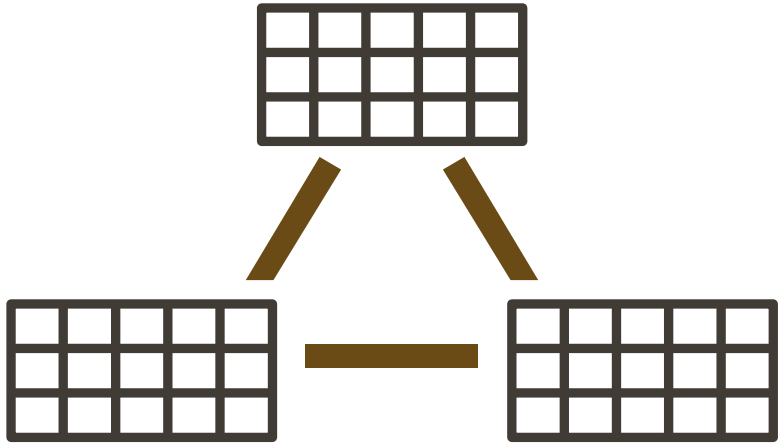
- Easily drag-and-drop visuals
- Re-use of components (when expanding the model)
- Optimize end-user rendering performance

What is a good data model?

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

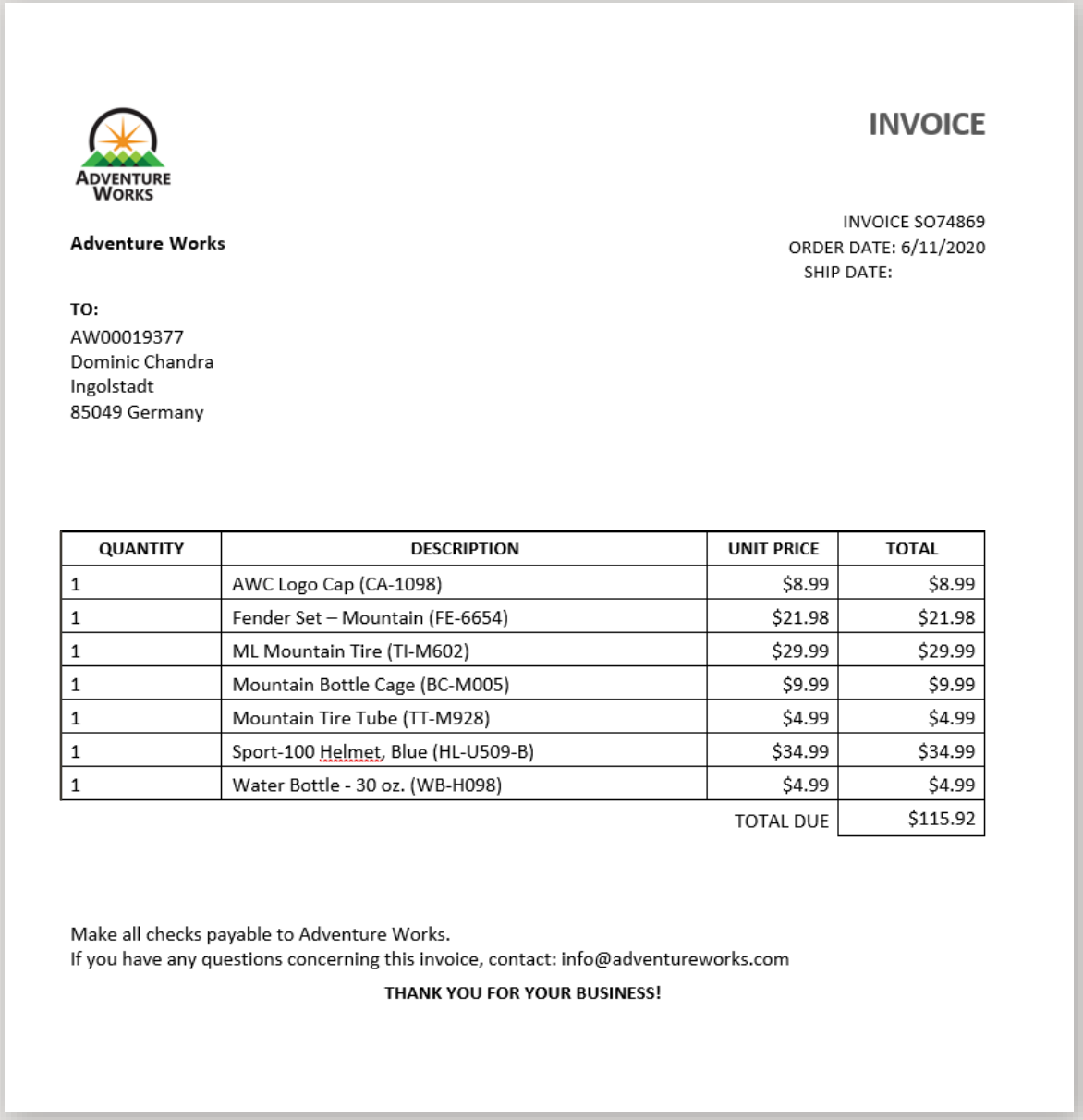
A dimensional data model consists of:

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



Building a dimensional data model

Starting point



ADVENTURE WORKS

Adventure Works

INVOICE

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

TO:
AW00019377
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 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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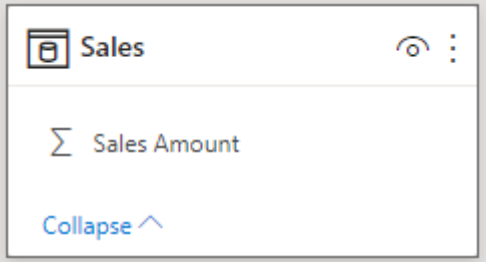
Tables

Sales

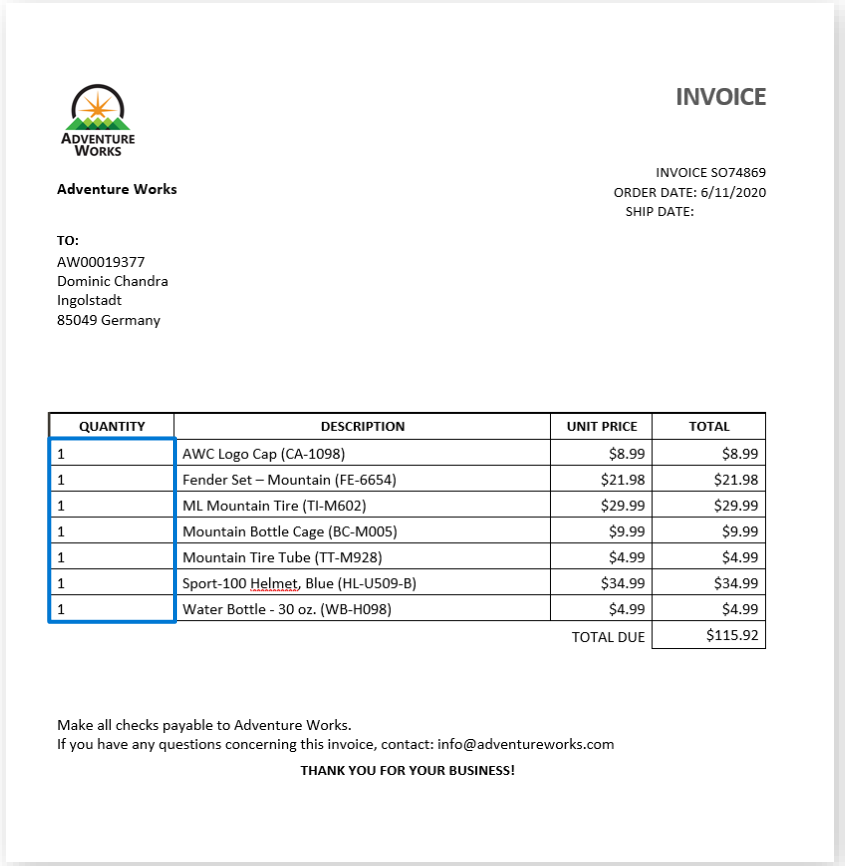
Sales Amount
$8.99
$21.98
$29.99
$9.99
$4.99
$34.99
$4.99

Diagram



Building a dimensional data model

Adding Order Quantity fact



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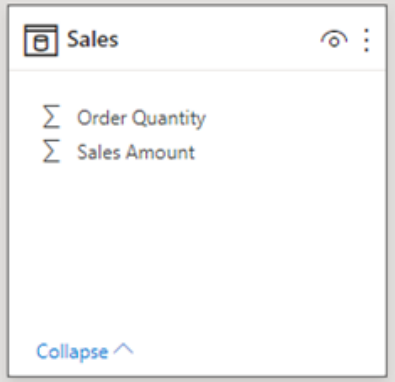
Tables

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

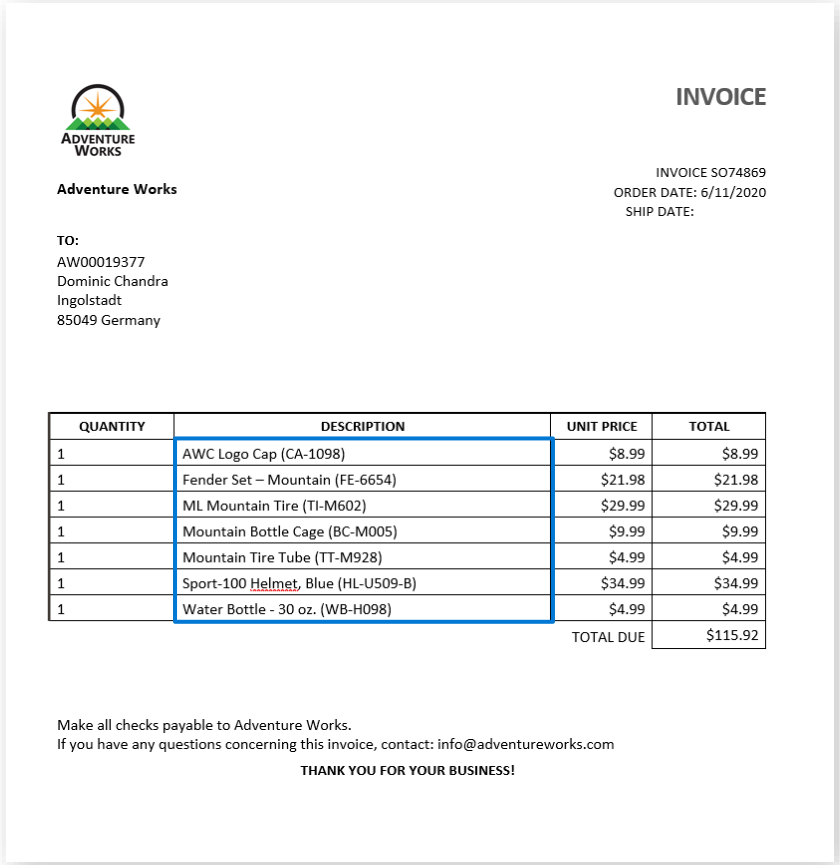
Usefulness limited without context

- 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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Tables

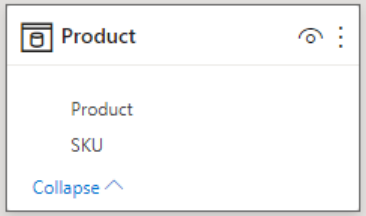
Product

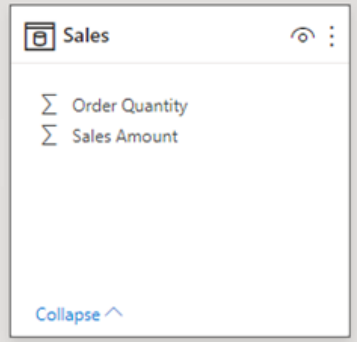
SKU	Product
CA-1098	AWC Logo Cap
FE-6654	Fender Set - Mountain
TI-M602	ML Mountain Tire
BC-M005	Mountain Bottle Cage
TT-M928	Mountain Tire Tube
HL-U509-B	Sport-100, Helmet, Blue
WB-H098	Water Bottle - 30 oz.

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





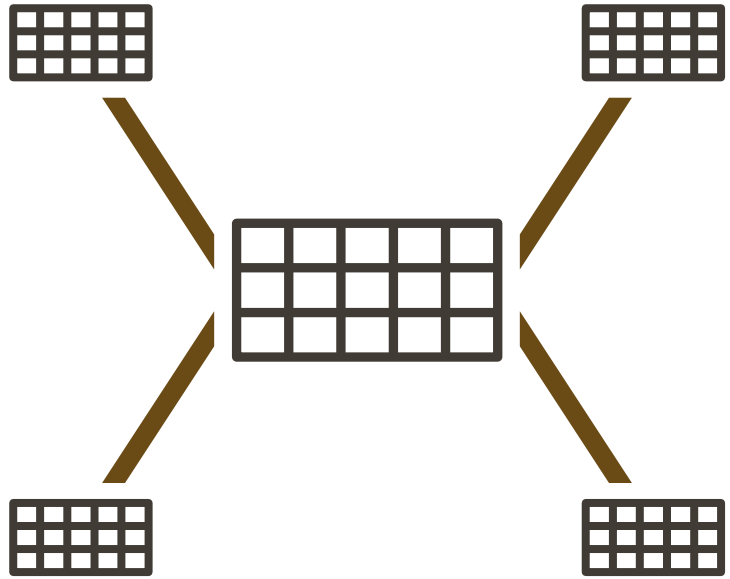
Dimension table

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

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

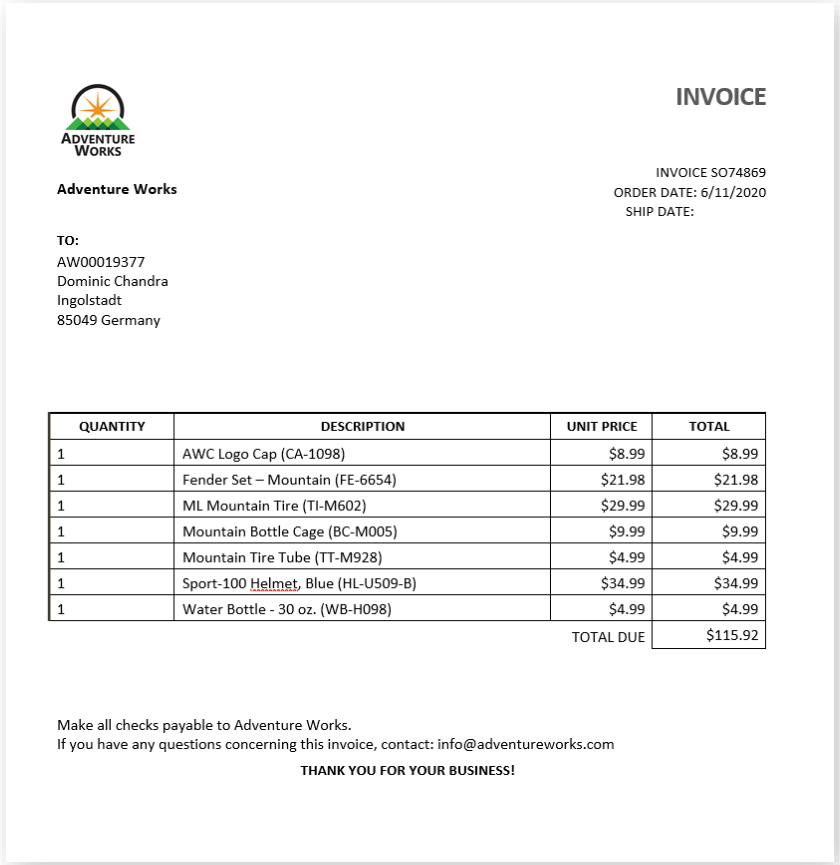
Without dimensions there is no context.

Also called: Lookup table on steroids.



Building a dimensional data model

Adding Product attribute to fact table



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Tables

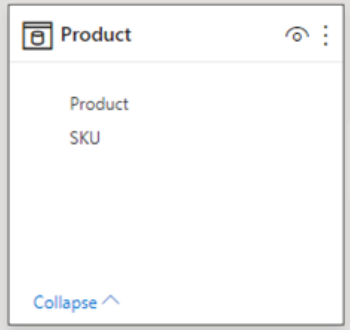
Product

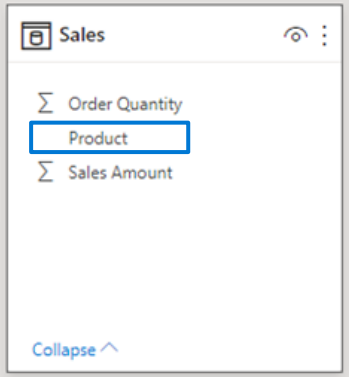
SKU	Product
CA-1098	AWC Logo Cap
FE-6654	Fender Set - Mountain
TI-M602	ML Mountain Tire
BC-M005	Mountain Bottle Cage
TT-M928	Mountain Tire Tube
HL-U509-B	Sport-100, Helmet, Blue
WB-H098	Water Bottle - 30 oz.

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

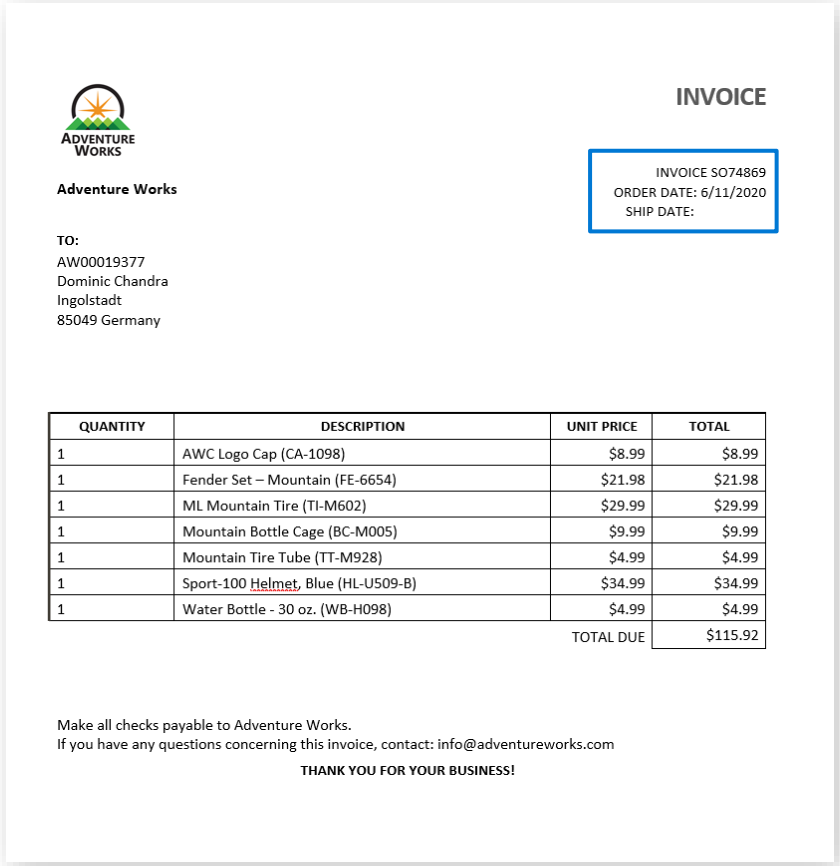
Diagram





Building a dimensional data model

Adding Sales Order and Order Date attribute to fact



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Dominic Chandra
Ingolstadt
85049 Germany

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1	Water Bottle - 30 oz. (WB-H098)	$4.99	$4.99
		TOTAL DUE	$115.92

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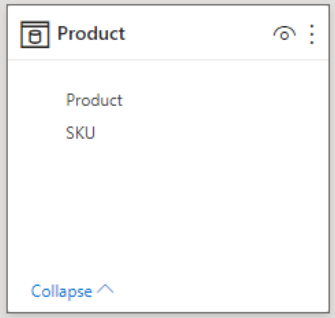
Tables

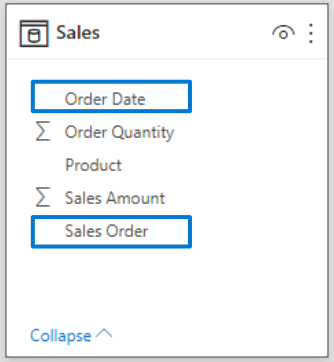
Product

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

Diagram





Building a dimensional data model

Adding relationship between Product and Sales

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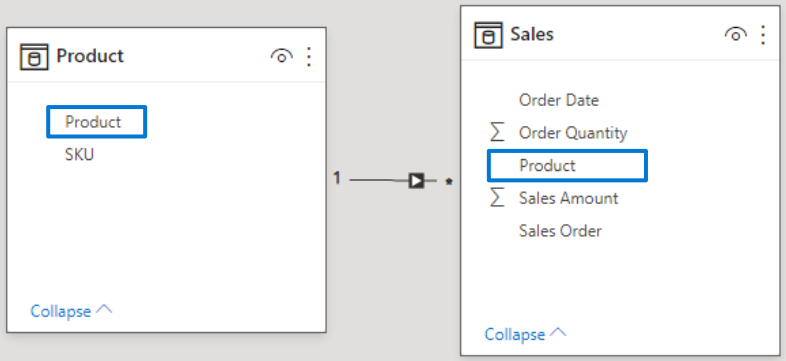
Tables

Product

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

Diagram



Relationships

Data-Marc.com

Relationship

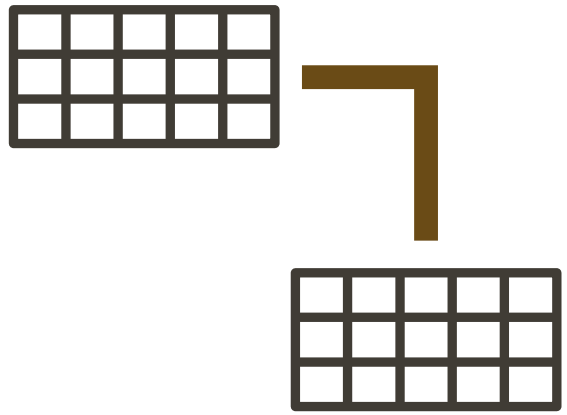
Connection between two tables using columns from each.

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-B	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-B	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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1	ML Mountain Tire (TI-M602)	$29.99	$29.99
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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

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

Customer

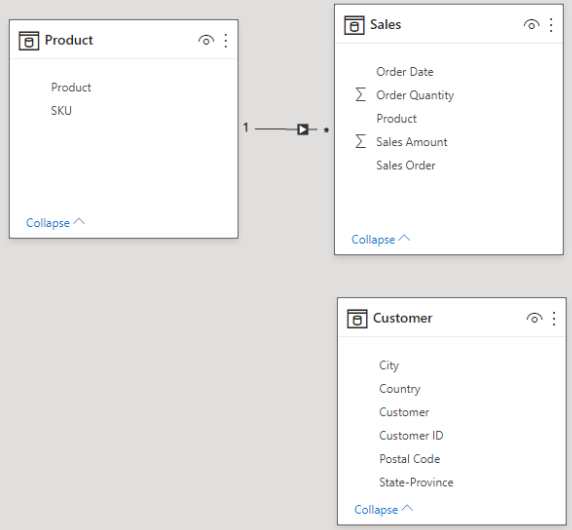
Customer ID	Customer	City	Postal Code	Country	State-Province
AW00019377	Dominic Chandra	Ingolstadt	85049	Germany	Bayern

Sales

Sales Amount	Order Quantity	Product	Sales Order	Order Date
$8.99	1	CA-1098	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 customer attribute on fact and relationship

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
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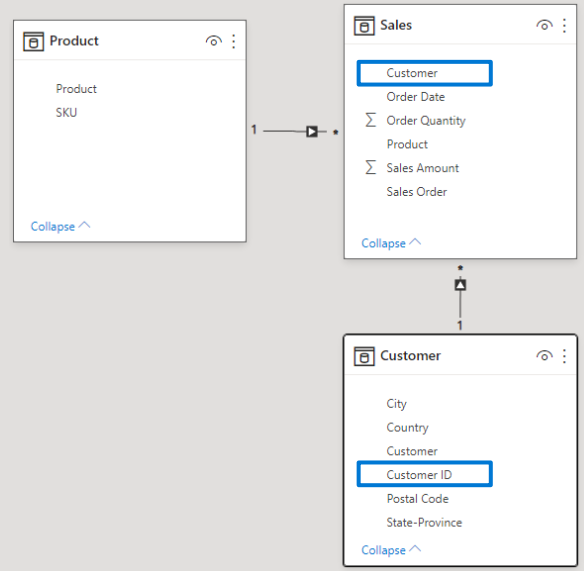
$4.99	1	TT-M928	SO74869	6/11/2020
$34.99	1	HL-U509-B	SO74869	6/11/2020
$4.99	1	WB-H098	SO74869	6/11/2020
$8.99	2	CA-1098	SO74870	7/11/2020

Product

Diagram



Data-Marc.com

Building a dimensional data model

Adding Date dimension and relationship

INVOICE

Adventure Works

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

TO:
AW00019377
Dominic Chandra
Ingolstadt
85049 Germany

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
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		TOTAL DUE	$115.92

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THANK YOU FOR YOUR BUSINESS!

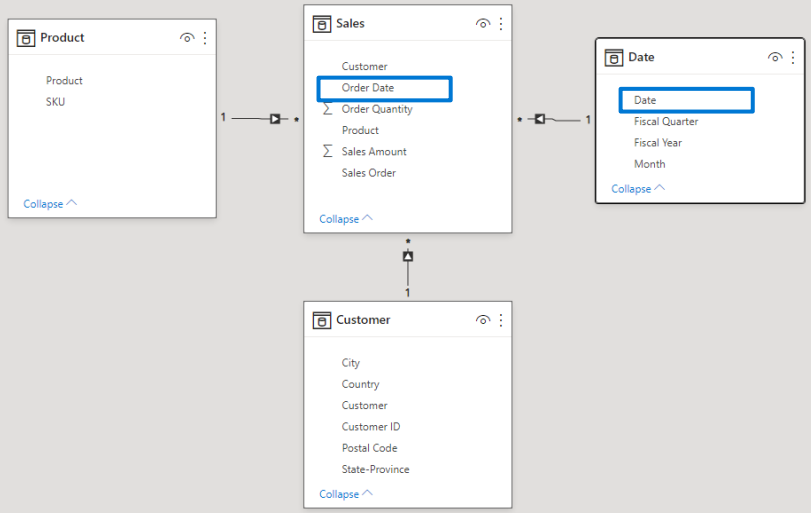
Tables

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



Building a dimensional data model

Adding Ship Date attribute and relationship

INVOICE

Adventure Works

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

TO:
AW00019377
Dominic Chandra
Ingolstadt
85049 Germany

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
1	AWC Logo Cap (CA-1098)	$8.99	$8.99
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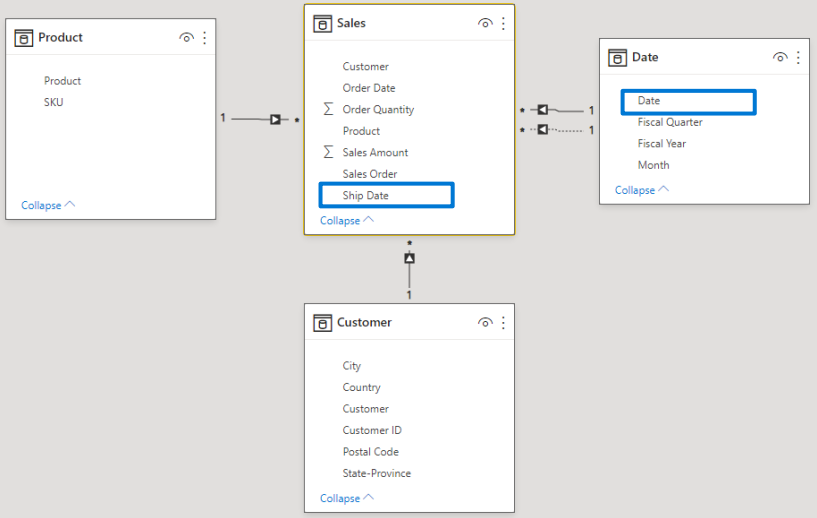
Date	Fiscal Quarter	Fiscal Year	Month
6/11/2020	FY2020 Q4	FY2020	2020 Jun
7/11/2020	FY2021 Q1	FY2021	2021 July

Product | Customer | Sales

Diagram



Data-Marc.com

Role playing dimension

Role playing dimension: same dimension being used multiple times

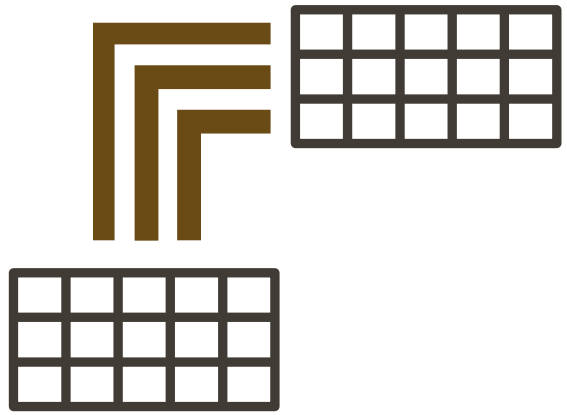
Example: Date dimension (OrderDate, ShipDate)

In Power BI: one active relationship between two tables

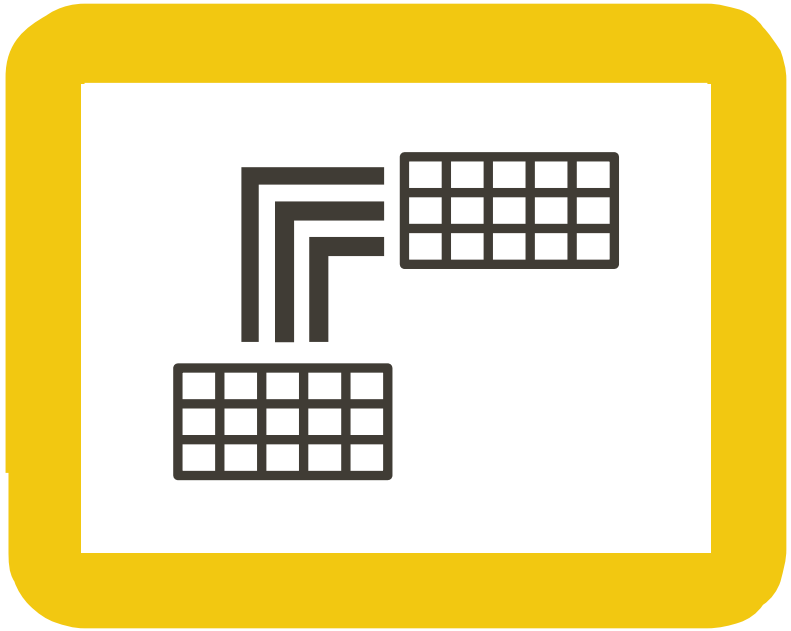
- Any other will be inactive
- USERELATIONSHIP()

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



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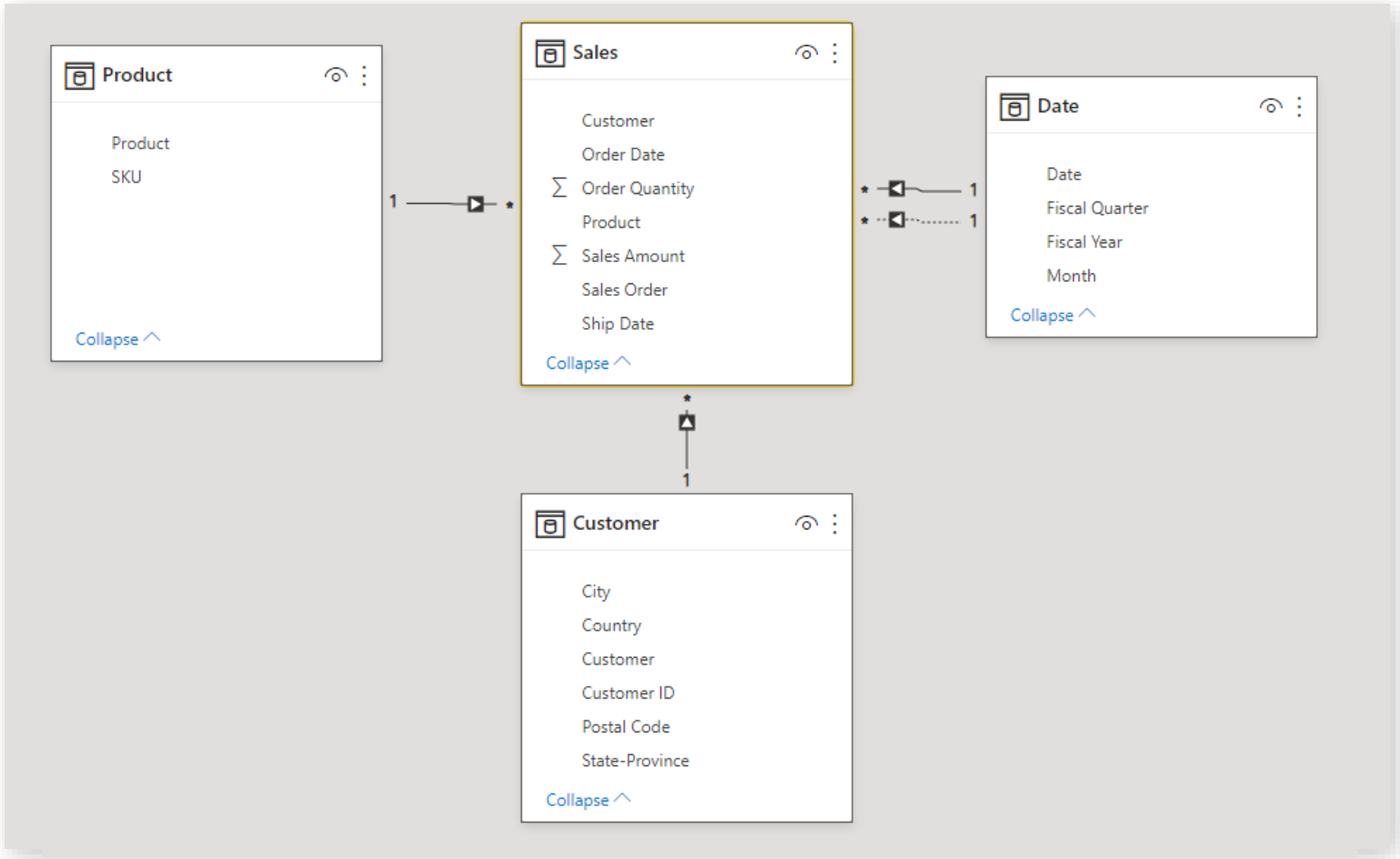
Building a dimensional data model

Final model

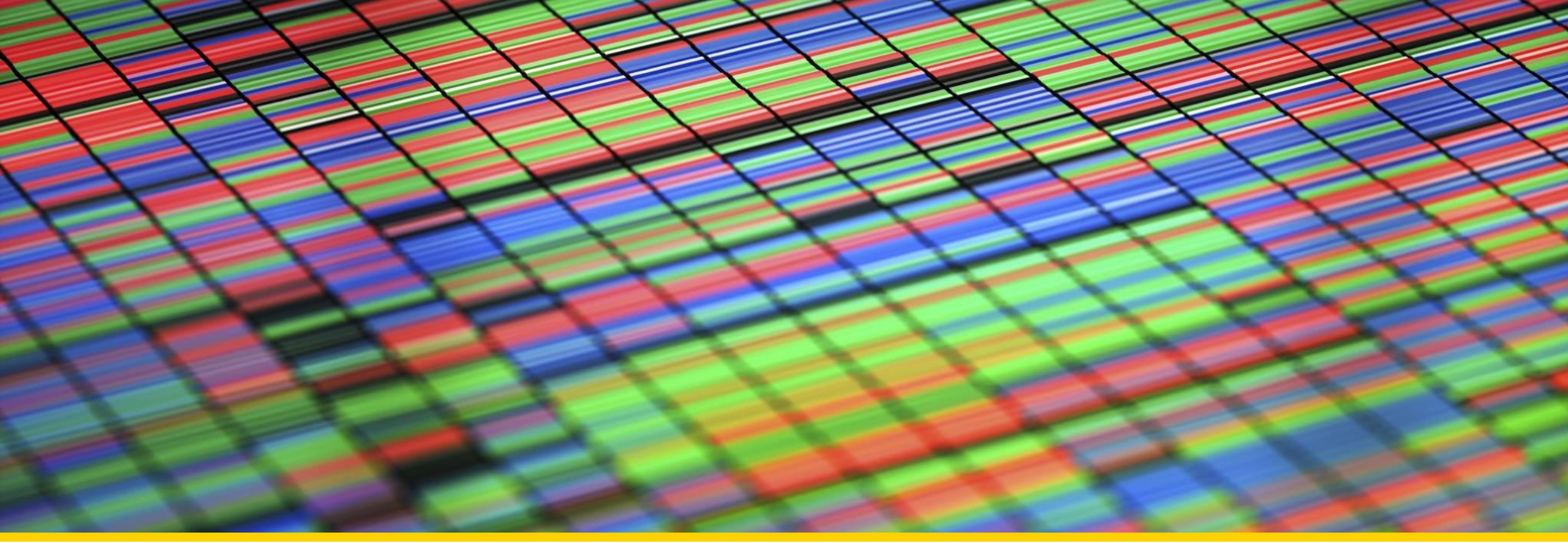


Note

This is a simplified, imperfect data model:

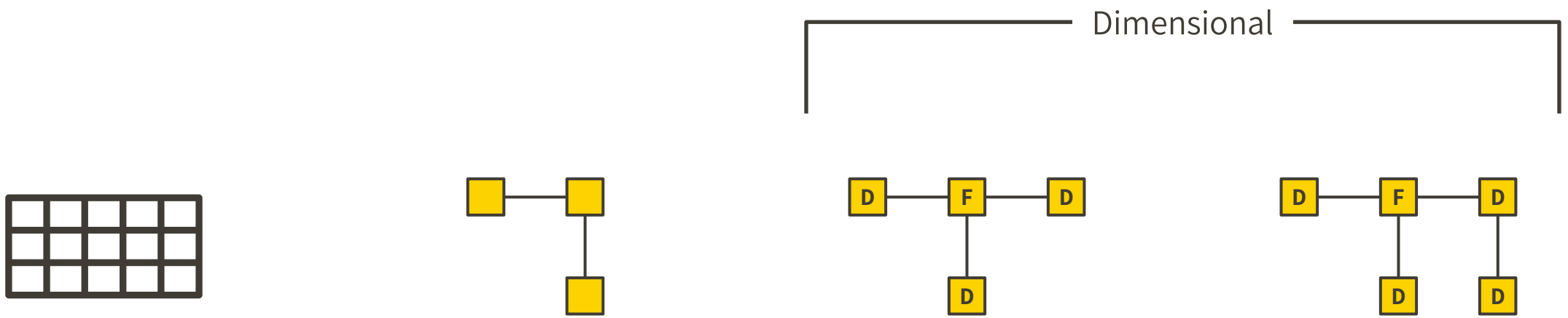
- Keys should be numerical instead of strings (surrogate keys)
- Sales Order should be separate dimension since the fact is on Sales Order Line, not Sales Order.

Open discussion



Data model types

Major types of data models



Flat

Normalized
(n^{th} normal form)

Star

Snowflake

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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

Data-Marc.com

Considerations for data modeling in Power BI

Do data cleansing activity in one place.

- Data platform
- Database views
- Power Query

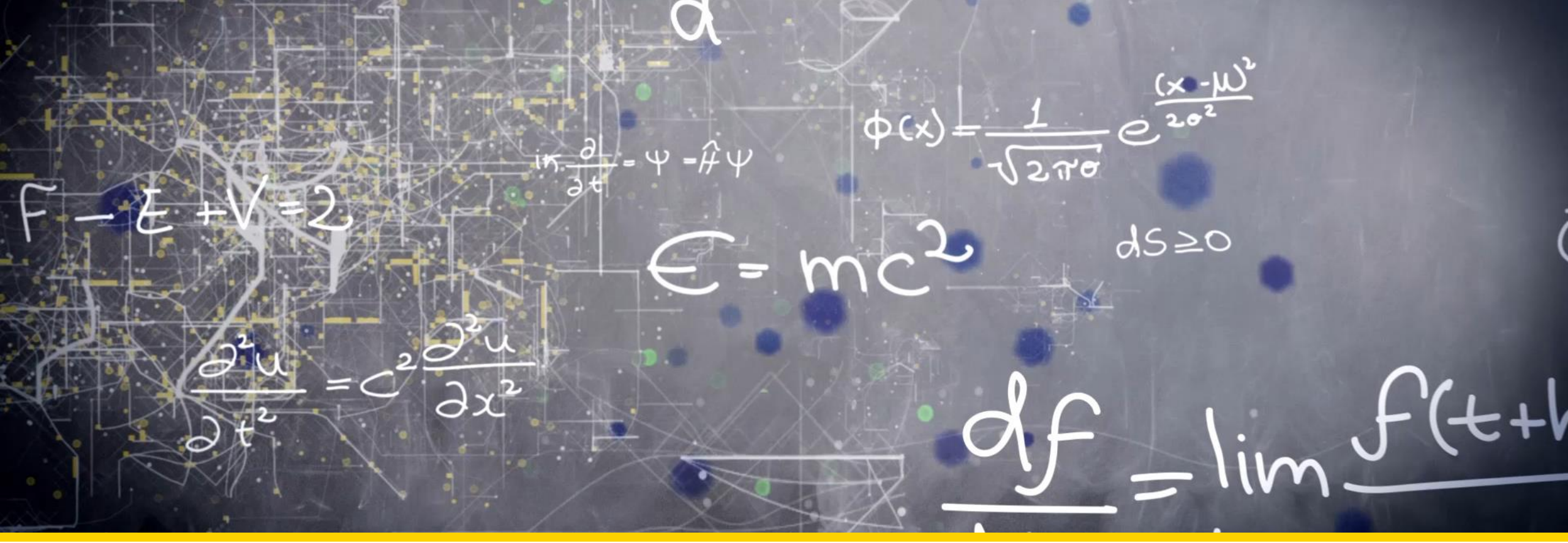
Enrich your data with measures and calculated columns.

Roche's Maxim of Data Transformation

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

Matthew Roche

Read more on his blog: https://ssbipolar.com/2021/05/31/roches-maxim/



Calculations

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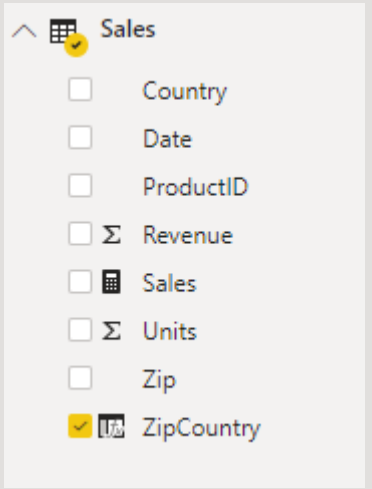
Calculated Column

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")))
```

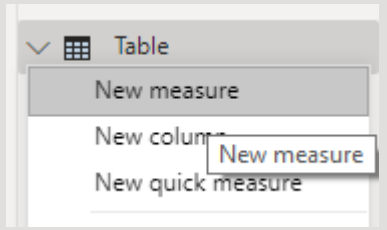


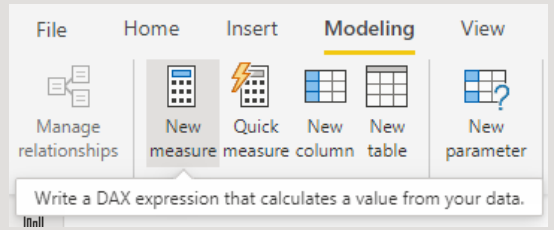
Measure

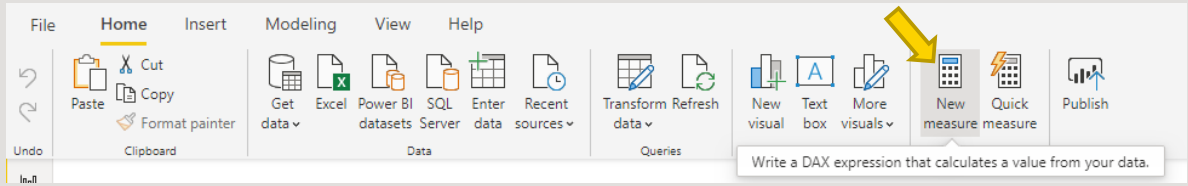
To create a measure using a DAX formula, select the New measure button from the Modeling tab.

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







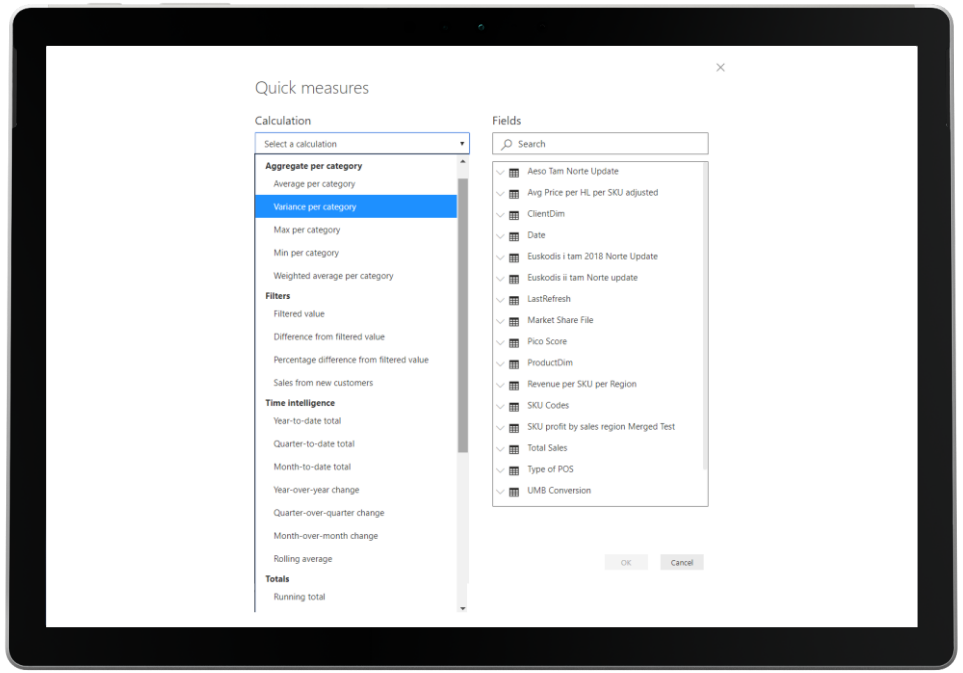
Calculated column vs Measure

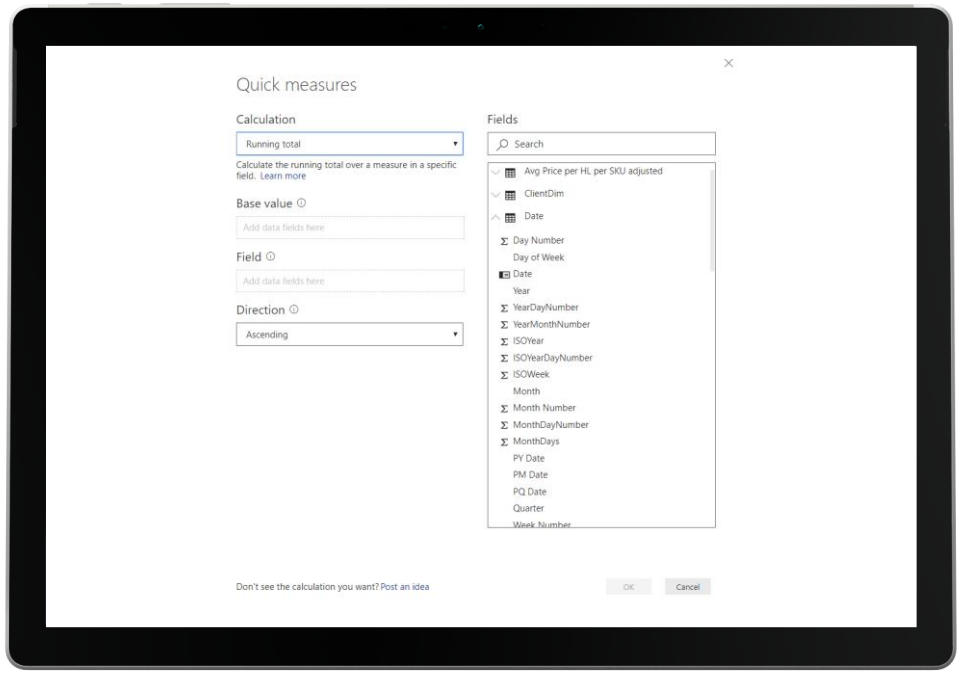
	Calculated Column	Measure
Persistence	Definition and result saved in data model	Definition saved in data model, result is calculated when a visual is created
Usage	Can be used on slicers, filters, rows, columns, etc.	Can only be used as a value in a visual and visual level filters
Language	DAX / M (Power 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?

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
Watch now

Webinar Series: Mastering Data Modeling with Power BI
Episode 3 - Data Modeling for Experts with Power BI
by Jeroen ter Heerdt and Marc Lelijveld
Watch now

Webinar Series: Data Modeling with Power BI
Episode 4 - Calculation Groups and Composite Models
Watch now

Find them all here:
docs.microsoft.com/en-us/power-bi/fundamentals/webinars

Thanks for attending!

Marc Lelijveld
Solution Architect – Data & Analytics
Macaw Netherlands

@MarcLelijveld
linkedin.com/in/MarcLelijveld
Data-Marc.com
Data-Marc