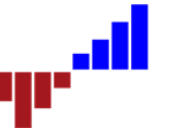


DAX From The Trenches

Lessons & Recommended Practices



Microsoft Data Platform MVP. He consults, writes, speaks, teaches & blogs about business intelligence and reporting solutions

Principal Consultant, Intelligent Business LLC

Work with companies to visualize and deliver critical information to make informed business decisions

Director of the Oregon SQL PASS chapter & user group

Author of Professional SQL Server 2016 Reporting Services and 14 other titles from Wrox, Packt & Microsoft Press



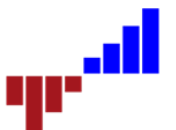
paul@IntelligentBiz.net



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



sqlserverbiblog.com

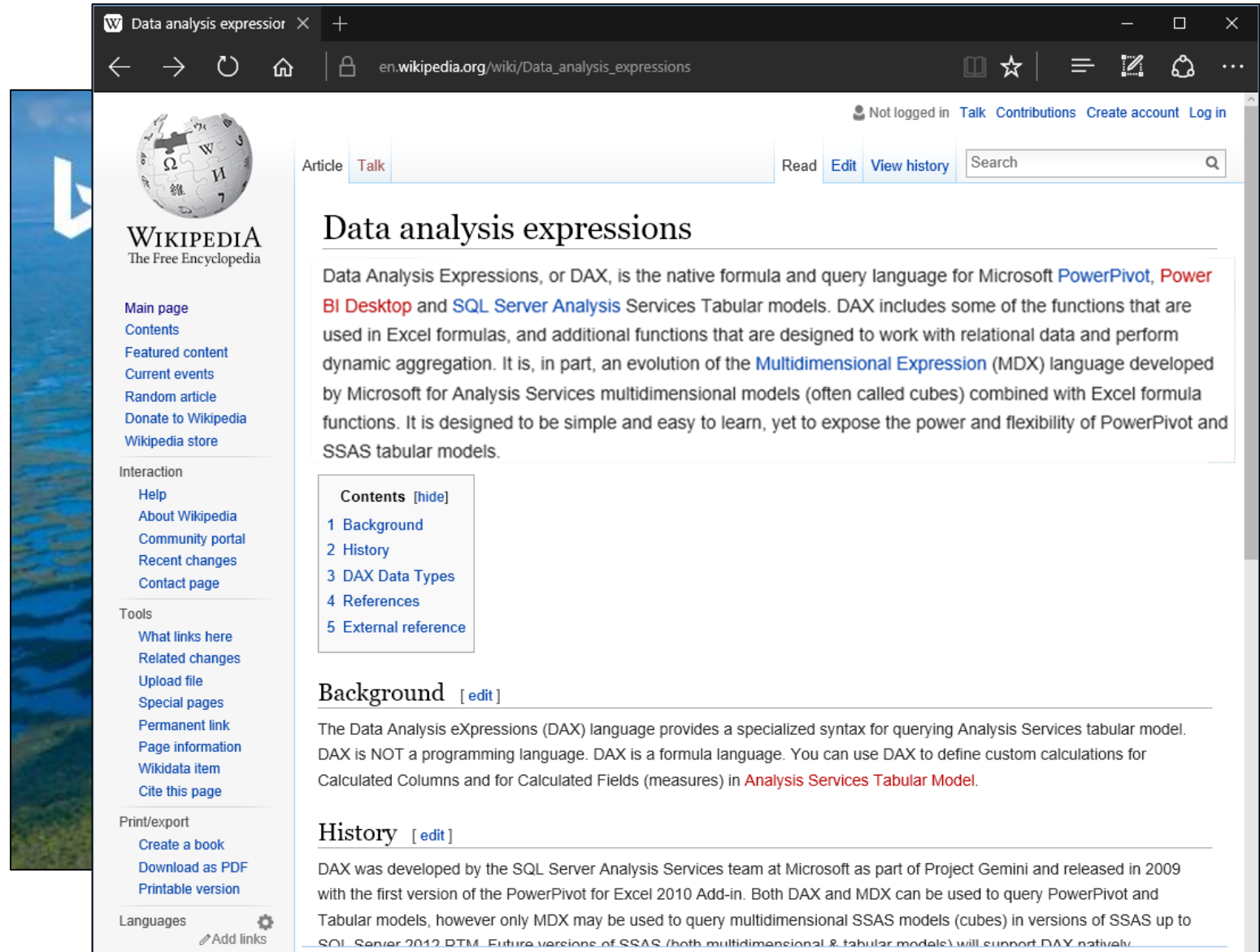


DAX

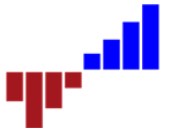
What is DAX?

Where is it used?

Where did it come from?



The screenshot shows a web browser window displaying the Wikipedia article for "Data analysis expressions". The browser's address bar shows the URL "en.wikipedia.org/wiki/Data_analysis_expressions". The page features the Wikipedia logo and navigation links such as "Main page", "Contents", and "Interaction". The main content area includes a table of contents with sections for "Background", "History", "DAX Data Types", "References", and "External reference". The "Background" section explains that DAX is a specialized syntax for querying Analysis Services tabular models, while the "History" section notes its development by the SQL Server Analysis Services team at Microsoft in 2009.



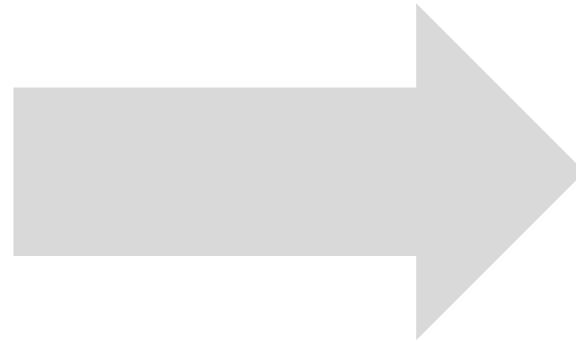
Expression Language

Query Language

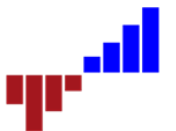
Excel
functions

MDX

SQL



DAX

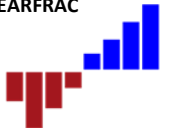


Learning DAX



- Understanding concepts & essentials is more important than memorizing functions
- You can always lookup function syntax
- Keeping a library of working examples may be more valuable than a web search

ABS	COUNTX	HOUR	NOT	SELECTCOLUMNS
ACOS	CROSSFILTER	IF	NOW	SIGN
ACOSH	CROSSJOIN	IFERROR	ODD	SIN
ACOT	CURRENCY	IGNORE	OPENINGBALANCEMONTH	SINH
ACOTH	CURRENTGROUP	INT	OPENINGBALANCEQUARTER	SQRT
ADDCOLUMNS	CUSTOMDATA	INTERSECT	OPENINGBALANCEYEAR	SQRTPI
ADDMISSINGITEMS	DATATABLE	ISBLANK	OR	STARTOFMONTH
ALL	DATE	ISCROSSFILTERED	PARALLELPERIOD	STARTOFQUARTER
ALLEXCEPT	DATEADD	ISEMPTY	PATH	STARTOFYEAR
ALLNOBLANKROW	DATEDIFF	ISERROR	PATHCONTAINS	STDEV.P
ALLSELECTED	DATESBETWEEN	ISEVEN	PATHITEM	STDEV.S
AND	DATESINPERIOD	ISFILTERED	PATHITEMREVERSE	STDEVX.P
ASIN	DATESMTD	ISLOGICAL	PATHLENGTH	STDEVX.S
ASINH	DATESQTD	ISNONTEXT	PERCENTILE.EXC	SUBSTITUTE
ATAN	DATESYTD	ISNUMBER	PERCENTILE.INC	SUBSTITUTEWITHINDEX
ATANH	DATEVALUE	ISO.CEILING	PERCENTILEX.EXC	SUM
AVERAGE	DAY	ISODD	PERCENTILEX.INC	SUMMARIZE
AVERAGEA	DEGREES	ISONORAFTER	PERMUT	SUMMARIZECOLUMNS
AVERAGEX	DISTINCT	ISSUBTOTAL	PI	SUMX
BETA.DIST	DISTINCTCOUNT	ISTEXT	POISSON.DIST	SWITCH
BETA.INV	DIVIDE	KEEPFILTERS	POWER	TAN
BLANK	EARLIER	LASTDATE	PREVIOUSDAY	TANH
CALCULATE	EARLIEST	LASTNONBLANK	PREVIOUSMONTH	TIME
CALCULATETABLE	EDATE	LCM	PREVIOUSQUARTER	TIMEVALUE
CALENDAR	ENDOFMONTH	LEFT	PREVIOUSYEAR	TODAY
CALENDARAUTO	ENDOFQUARTER	LEN	PRODUCT	TOPN
CEILING	ENDOFYEAR	LN	PRODUCTX	TOTALMTD
CHISQ.DIST	EOMONTH	LOG	QUOTIENT	TOTALQTD
CHISQ.DIST.RT	EVEN	LOG10	RADIANS	TOTALYTD
CHISQ.INV	EXACT	LOOKUPVALUE	RAND	TRIM
CHISQ.INV.RT	EXCEPT	LOWER	RANDBETWEEN	TRUNC
CLOSINGBALANCEMONTH	EXP	MAX	RANK.EQ	UNICODE
CLOSINGBALANCEQUARTER	EXPON.DIST	MAXA	RANKX	UNION
CLOSINGBALANCEYEAR	FACT	MAXX	RELATED	UPPER
COMBIN	FILTER	MEDIAN	RELATEDTABLE	USERRELATIONSHIP
COMBINA	FILTERS	MEDIANX	REPLACE	USERNAME
CONCATENATE	FIND	MID	REPT	VALUE
CONCATENATEX	FIRSTDATE	MIN	RIGHT	VALUES
CONFIDENCE.NORM	FIRSTNONBLANK	MINA	ROLLUP	VAR.P
CONFIDENCE.T	FIXED	MINUTE	ROLLUPADDSUBTOTAL	VAR.S
CONTAINS	FLOOR	MINX	ROLLUPGROUP	VARX.P
COS	FORMAT	MOD	ROLLUPISSUBTOTAL	VARX.S
COSH	GCD	MONTH	ROUND	WEEKDAY
COT	GENERATE	MROUND	ROUNDDOWN	WEEKNUM
COTH	GENERATEALL	NATURALINNERJOIN	ROUNDUP	XIRR
COUNT	GEOMEAN	NATURALLEFTOUTERJOIN	ROW	XPV
COUNTA	GEOMEANX	NEXTDAY	SAMEPERIODLASTYEAR	YEAR
COUNTAX	GROUPBY	NEXTMONTH	SAMPLE	YEARFRAC
COUNTBLANK	HASONEFILTER	NEXTQUARTER	SEARCH	
COUNTROWS	HASONEVALUE	NEXTYEAR	SECOND	



Recommended Practice #1

Learn these first:

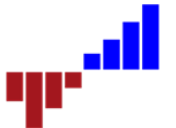
SUM, AVERAGE, MIN, MAX

COUNT, COUNTROWS

CALCULATE

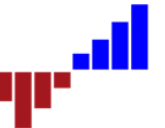
FILTER

IF



Concepts

- Row context
- Filter context
- Filter propagation
- Aggregators
- Iterators
- Calculated columns
- Implicit measures
- Explicit measures



Aggregators

Standard aggregates

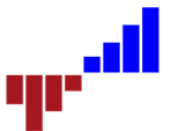
- SUM
- AVERAGE
- MIN
- MAX
- STDEV
- VAR

Counters

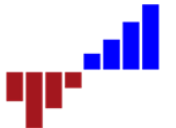
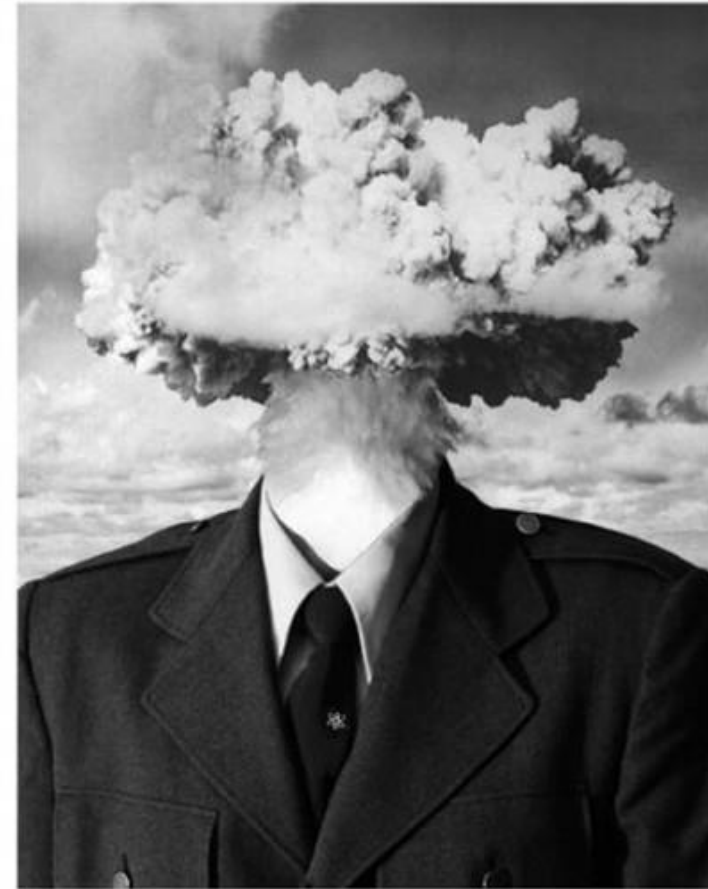
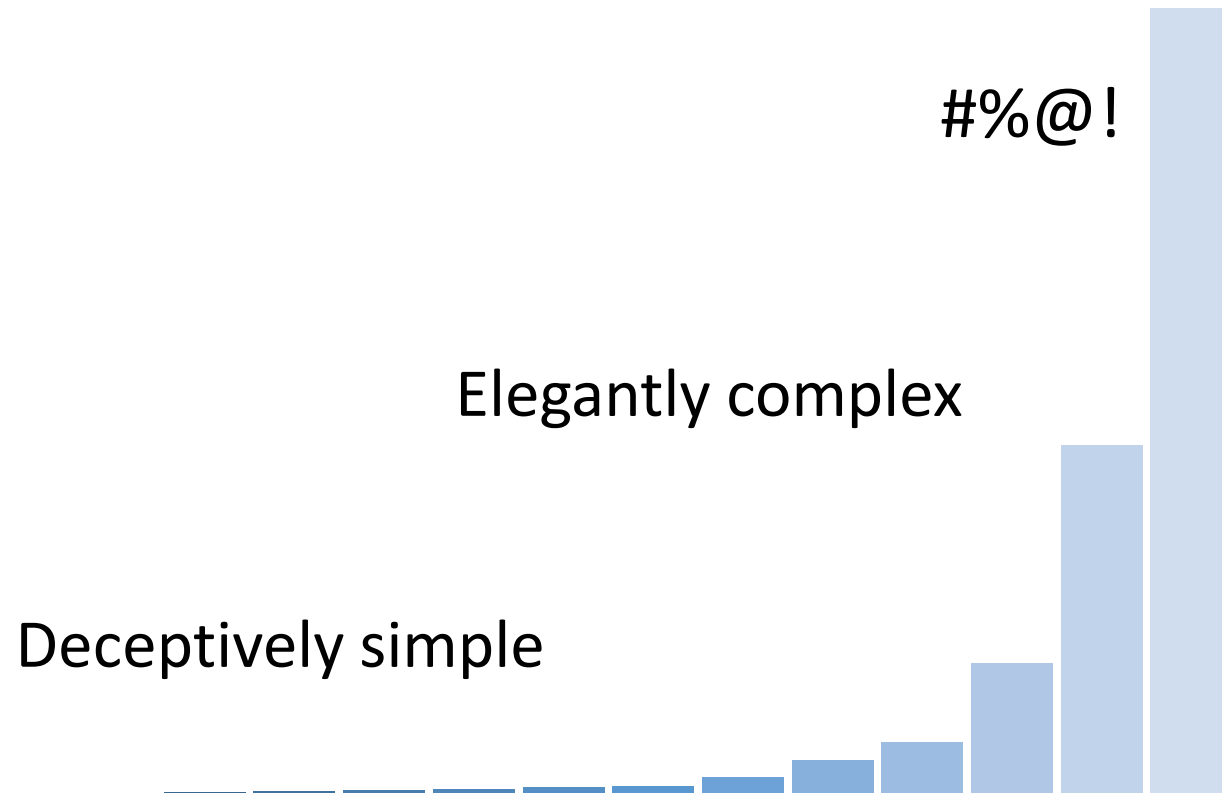
- COUNT
- COUNTBLANK
- COUNTROWS
- COUNTDISTINCT

Type agnostic

- SUMA
- AVERAGEA
- MINA
- MAXA
- COUNTA



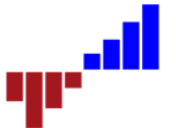
Learning Curve



Recommended Practice #2

Don't try to memorize complex DAX

- Focus on understanding the concepts and patterns rather than the language syntax
- Build a library of useful examples, books & articles
- Work in iterations



Calculated Columns & Measures

Columns

- are calculated at data load & refresh time
- store results in the model

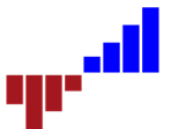
Measures

- are calculated at query time
- incur no storage overhead

Report Status	LastModelUpdate
0-Not Started	5/25/2016 1:25:29 PM
1-In Process	5/25/2016 1:25:29 PM
2-Open Questions	5/25/2016 1:25:29 PM
3-Shell Complete	5/25/2016 1:25:29 PM
4-Development Complete	5/25/2016 1:25:29 PM
5-Testing Complete	5/25/2016 1:25:29 PM

Table Summary:

- Table Name: [LastModelUp...]
- Formula Bar: Last Update:=MIN([LastModelUpdate])
- Calculated Column: Last Update:=MIN([LastModelUpdate])
- Calculated Measure: Date Now:=NOW()
- Table Footer: Last Update: 5/25/2016 1:25:29 PM, Date Now: 5/25/2016 1:25:32 PM



Object Naming Rules

Rule #1:

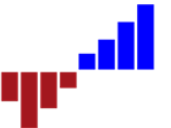
- Make sure you name tables, columns & measures correctly before you get started with calculations

Rule #2:

- Disregard rule #1 because you're never going to name everything correctly before you get started and will inevitably make changes throughout your project

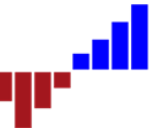
Rule #3:

- Do your best to apply correct naming standards and be content with evolutionary changes throughout your project. Plan to “clean house” at regular intervals and sync-up naming and design changes



Object Naming Guidelines

- Don't expose cryptic source object names to users
- Every table, visible column and measure supports the user experience. Use intuitive names that make sense to users.
- Design a prototype. Test it with an Excel pivot table and/or Power BI.
- Use most intuitive names and then add synonyms to support Q&A.



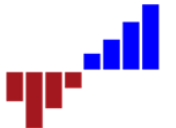
Example

Project Progress Scorecard

Report Log Grouped by Report ID

Last Refresh: 5/25/16 1:25 PM

Business Area	Report ID	Report Title	Responsible Org	Requirements %	Sprocs %	Reports %	Overall Progress %
Finance	F10008	W&T Revenue by Inventory Type	IS&CO	25 %	60 %	60 %	48.33 %
Finance	F10008	Revenue Ranking	IS&CO	25 %	48 %	48 %	40.33 %
Finance	F10008	Accountable Revenue Analysis	IS&CO	25 %	40 %	40 %	35.00 %
Finance	F10048	W&T Revenue Report	IS&CO	25 %	60 %	49 %	44.52 %
Finance	F10048	W&T Revenue Report	IS&CO	25 %	60 %	60 %	48.33 %
Finance	F10078	W&T Revenue Report	IS&CO	0 %	40 %	0 %	13.33 %
Finance	F10088	Average Dept To Pay	IS&CO	0 %	60 %	40 %	33.33 %
Finance	F10088	Average Dept To Pay Detail	IS&CO	25 %	40 %	60 %	41.67 %
Finance	F10088	Budgeted Afford Report	IS&CO	25 %	60 %	60 %	48.33 %



Implicit & Explicit Measures

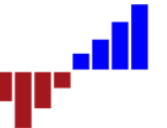
Two schools of thought:

1. Power BI should behave like Excel

- Excel uses implicit measures with workbook data
- PivotTables & charts:
 - SUM numbers by default
 - COUNT text by default
- Power BI Desktop: numeric columns have Summarize By property

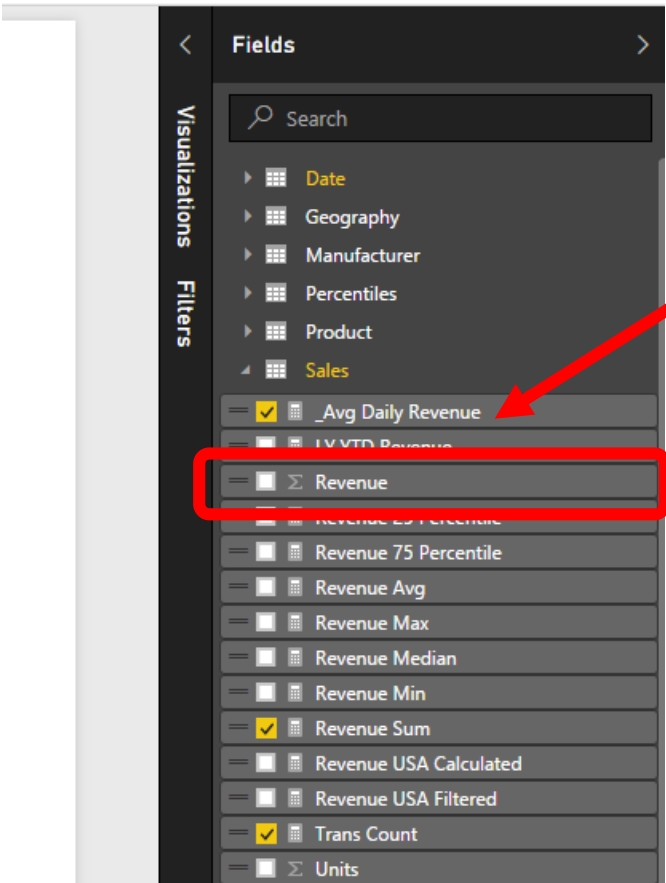
2. All measures should be explicitly defined

- Model designer maintains control
- Default behavior may not always be right



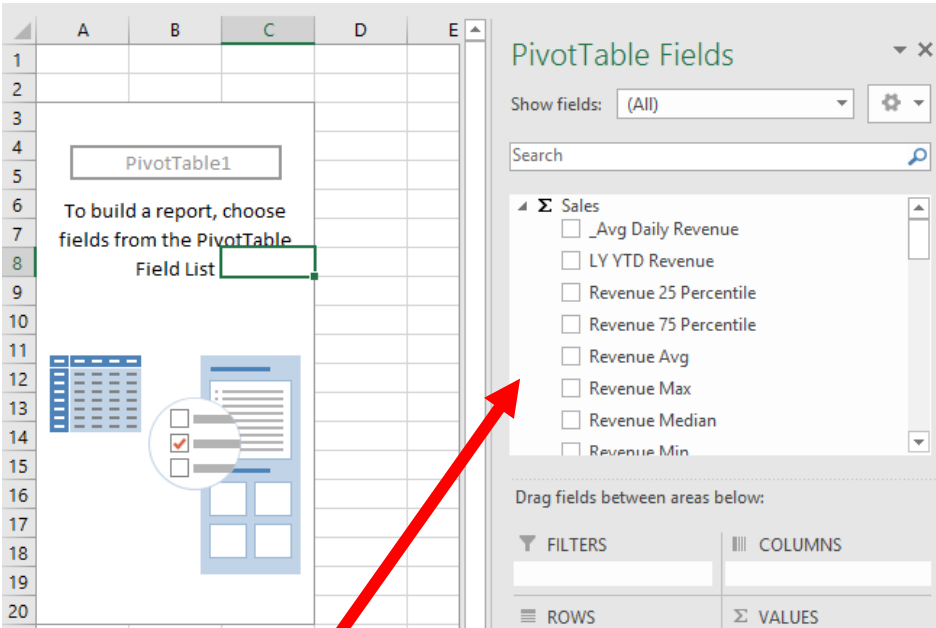
Implicit & Explicit Measures

Power BI

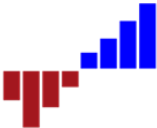


Implicit measure

Excel



No Implicit measure



Measure Design Practices

- Set **Summarize By** property for all numeric columns
- Define explicit measures & hide base columns
- Be meticulous and deliberate with naming standards
- There simply is no “one size fits all” naming standard

Revenue

Total Revenue

Sum of Revenue

Avg Revenue

Revenue Sum

Revenue Avg

MTD Revenue

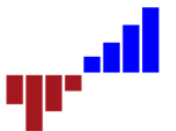
YTD Revenue

Revenue MTD

Revenue YTD

Revenue YTD % of Target

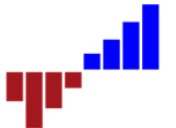
Revenue YTD Pct of Target



Recommended Practice #3

Object Names, Columns & Measures

- If you don't need it, delete it
- Keep internal column names hidden
- Rename columns, use calculated columns & measures to define user-friendly names
- Use explicit measures where possible

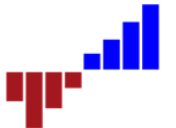


What Measures Do We Need?

The typical conversation

Designer / Consultant

Stakeholder / User



Basic Measure Pattern

- **Natural filter context**

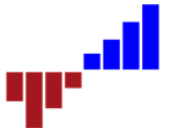
Total Revenue = SUM(Sales[Revenue])

- **Alter natural filter context**

Central Region Revenue =
CALCULATE(
SUM(Sales[Revenue]), Geography[Region] = "Central"
)

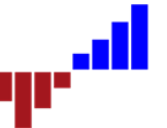
- **Override natural filter context**

All Central Region Revenue =
CALCULATE(
SUM(Sales[Revenue]),
FILTER(ALL(Sales), RELATED(Geography[Region]) = "Central")
)



Time Intelligence

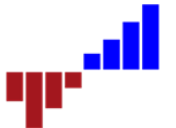
- NOW, DATE, TIME
- DATEADD
- DATEDIFF
- DATESMTD
- DATESBETWEEN
- TOTALMTD ...QTD, YTD
- NEXTMONTH ...DAY, QUARTER, YEAR
- PARALLELPERIOD



Recommended Practice #4

Define Measures in Categories:

- Simple aggregates
- Time variances
- Ratios & differentials
- Business-specific calculations
- KPI parts (e.g. Target, Status, Trend)

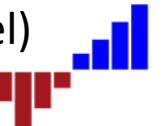


Fun Fact

Time Values: Party like it's 1899

- Date/time values with only a time element are recorded on Dec 30, 1899
- How is this possible when the first supported date value is 1/1/1900?
- Microsoft adopted the date calculation algorithm from Lotus 1-2-3 that erroneously recorded 1900 as a leap year
- Date-related functions internally correct the error but internally, the calendar begins one day early (actually, 2 days but I don't know why)
- **Format “time only” values without the date**

Source: PowerPivot for the Data Analyst, Bill Jelen (Mr Excel)



DAX Tools

Excel 2010 /SSAS 2012, 2014

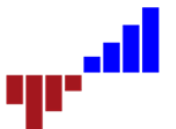
- Excel 2010, 2013
- SSDT-BI
- NotePad++
- DAXFormatter.com

Power BI Desktop /Excel 2013+

- Power BI Desktop
- Excel
- **DAX Studio**

SSAS Tabular

- SSDT for Visual Studio 2015
- SSMS
- Excel
- **DAX Studio**



Next Level

- Modifying filter and row context:

`ALL()`, `ALL(table)`, `ALLSELECTED(table[col])`

`ALLSELECTED()`, `ALLSELECTED(table)`, `ALLSELECTED(table[col])`

- Conditional logic:

`HASONEVALUE(table[col])`

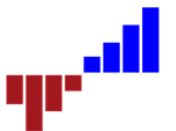
- Ranking:

Product Revenue Rank =

`RANKX(ALL('Product')`

`, SUMX(RELATEDTABLE(Sales), [Revenue])`

`)`

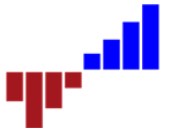


Iterators

- SUMX
- AVERAGEX
- MINX
- MAXX
- COUNTX
- COUNTAX
- PRODUCTX
- CONCATENATEX

Mixed totals: Operates on one row at a time, accumulating the result of the prior iteration

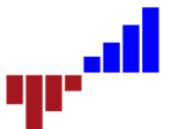
Category	Month	Revenue per Unit	Revenue per Unit Accum	Month List
Mix	Jan	\$380.80	\$380.80	Jan
	Feb	\$380.85	\$380.85	Feb
	Mar	\$364.12	\$364.12	Mar
	Apr	\$363.05	\$363.05	Apr
	May	\$362.93	\$362.93	May
	Jun	\$365.12	\$365.12	Jun
	Jul	\$364.19	\$364.19	Jul
	Aug	\$367.87	\$367.87	Aug
	Sep	\$372.46	\$372.46	Sep
	Oct	\$393.20	\$393.20	Oct
	Nov	\$391.08	\$391.08	Nov
	Dec	\$392.53	\$392.53	Dec
	Total	\$371.15	\$4,498.21	Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec
Rural	Jan	\$206.66	\$206.66	Jan
	Feb	\$209.07	\$209.07	Feb
	Mar	\$203.84	\$203.84	Mar
	Apr	\$194.38	\$194.38	Apr
	May	\$185.97	\$185.97	May
	Jun	\$180.53	\$180.53	Jun
	Jul	\$172.96	\$172.96	Jul
	Aug	\$185.09	\$185.09	Aug
	Sep	\$198.83	\$198.83	Sep
	Oct	\$204.80	\$204.80	Oct
	Nov	\$184.68	\$184.68	Nov
	Dec	\$148.92	\$148.92	Dec
	Total	\$185.89	\$2,275.73	Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec



DAX Variables

Scoped in a single calculation operation

```
Revenue Growth % =  
VAR CurrentRev = SUM ( Sales[Revenue] )  
VAR LastYearRev =  
    CALCULATE (  
        SUM ( Sales[Revenue] ),  
        SAMEPERIODLASTYEAR ( 'Date'[Date] )  
    )  
RETURN  
    DIVIDE ( CurrentRev - LastYearRev, LastYearRev )
```



Recommended Practice Round-up

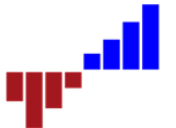
#1: Learn DAX essential functions

#2: Learn DAX concepts before function syntax

#3: Object naming

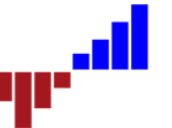
#4: Measure categories:

aggregates, time & ratios, business-specific, KPI parts



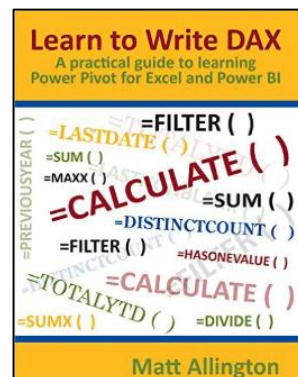
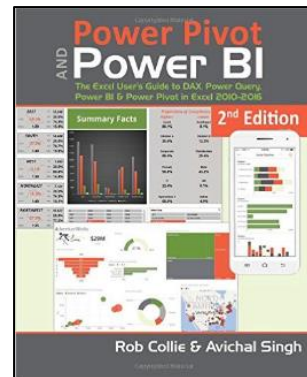
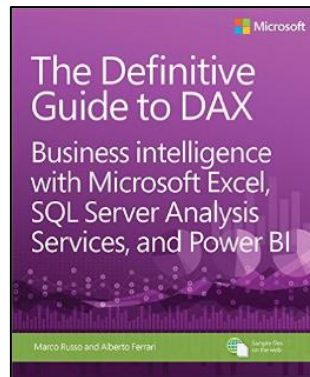


Questions?



Contact & Resources

- **DAX Studio**
daxstudio.codeplex.com
- **Books:**



paul@IntelligentBiz.net



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



sqlserverbiblog.com

