

Sum Product

BREAKING **B-I-G**
NEWS

NEWSLETTER #125 - April 2023

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Some B-I-G news this month!

Microsoft has recently announced Copilot. Whilst it's not yet available to most of us (it's a Copilot that's not been flighted [Groan – Ed.]), they are intent on building a frenzied clamour of interest for their new Microsoft 365 service. We provide details below.

There are plenty of other topics in here too. We detail things that have rolled out in our Excel and Power BI updates, plus have yet another Beat the Boredom Challenge, plus Charts & Dashboards, Visual Basics, Power Pivot Principles, Power Query Pointers, more Keyboard Shortcuts and finally, the A to Z of Excel functions actually ploughs through no less than THREE letters of the alphabet stopping off to remind us all of the new wunderkind **LAMBDA**.

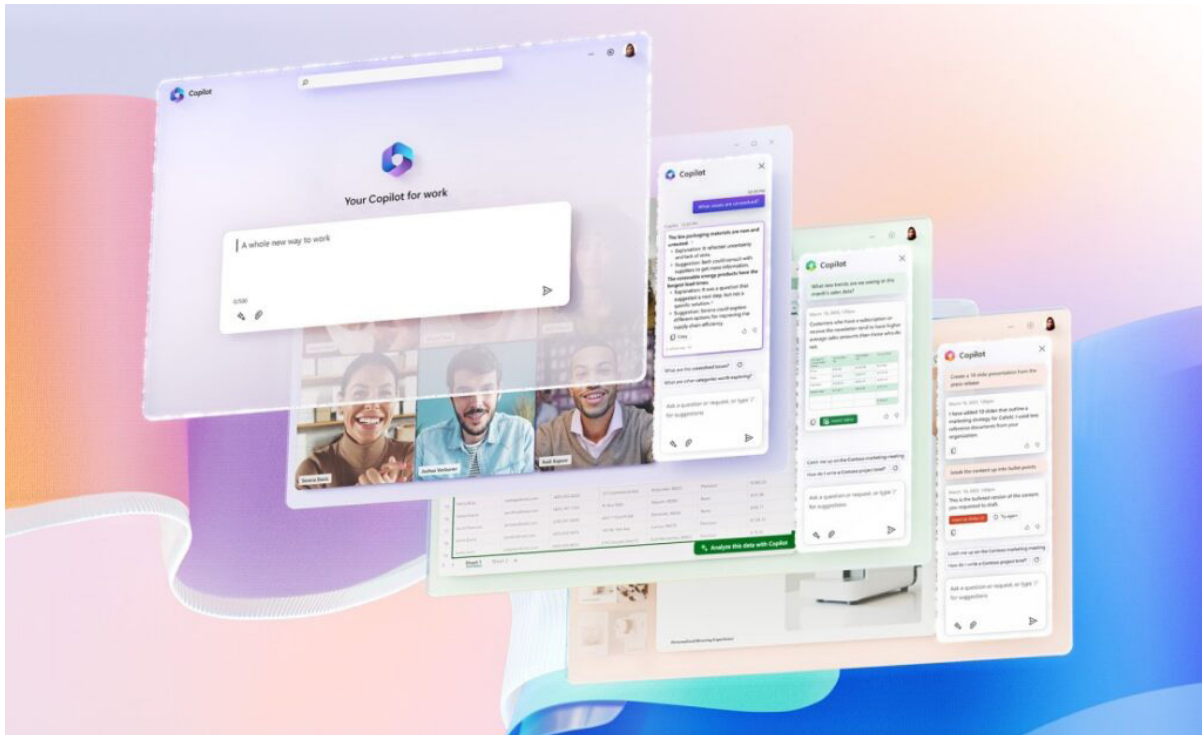
As always, happy reading and remember: stay safe, stay happy, stay healthy.

Liam Bastick, Managing Director, SumProduct



Need a Copilot?

Emanating from Github Copilot where developers fed back stating 88% felt they were more product, 77% said the tool helped them spend less time pounding the internet search engines and 74% stating their work became more satisfying, Microsoft announced Microsoft 365 Copilot in mid-March. And it's certainly whipped up a frenzy...



So what the heck is it?

Copilot combines the power of Large Language Models (LLMs) with data in your Microsoft 365 apps, products and services to convert your words into productivity tools – all whilst maintaining the software giant's existing commitments to data security and privacy in the enterprise.



It's integrated into Microsoft 365 in two ways:

1. It is **embedded in the Microsoft 365 apps** (e.g. Word, Excel, PowerPoint, Outlook, Teams) to facilitate more creative and productive solution, upgrading your skills at the same time
2. **Business Chat**: this works across the LLM, the Microsoft 365 apps, and your data (e.g. calendar, emails, chats, documents, meetings, contacts) to undertake tasks which would have been more complex to coordinate previously, such as "tell my team how we updated the product strategy" whereby it might generate a status update based on the morning's meetings, emails and chat threads.

Obviously we don't have access to it yet, but we summarise Microsoft's own comments below.

Copilot in Excel

This will work beside end users / modellers to help analyse and explore spreadsheet data. You will be able to ask Copilot questions about your data set in natural language, not just formulae, making Excel more accessible to all (looks like we might be out of a job then!). It can detail

correlations, propose what-if scenarios and suggest formulae based upon your questions, identify trends, create visuals, generating models based on your questions that help you explore your data without modifying it.

Microsoft lists the following as viable examples:

- Give a breakdown of the sales by type and channel, displaying the results in a table
- Project the impact of a 3% increase in inflation and generate a chart to help visualise
- Model how a change to the growth rate for staff wages would impact my gross margin.

Country	Customer	Product	Discount Band	Units Sold	Manufacturing Price	Sale Price	Gross Sales	Discounts	Sales	COGS
France	VanArsdel	Biodegradable Cleaning Products	Low	4345	\$10	\$352	\$1,529,440	\$15,294	\$1,514,146	\$15,294
USA	VanArsdel	Biodegradable Cleaning Products	Low	4245	\$10	\$352	\$1,494,240	\$14,942	\$1,479,298	\$14,942
Australia	VanArsdel	Biodegradable Cleaning Products	None	4124	\$10	\$352	\$1,451,648	\$0	\$1,451,648	\$0
Mexico	VanArsdel	Biodegradable Cleaning Products	Medium	3954	\$10	\$352	\$1,391,808	\$83,508	\$1,308,300	\$83,508
France	Contoso Pharmaceuticals	Biodegradable Cleaning Products	Low	4952	\$10	\$127	\$628,904	\$6,289	\$622,615	\$6,289
France	Contoso Pharmaceuticals	Recycled Can	Low	4903	\$5	\$127	\$622,681	\$6,227	\$616,454	\$6,227
Canada	Proseware	Natural Personal Care Products	Low	1954	\$270	\$302	\$590,108	\$5,901	\$584,207	\$5,901
Canada	Proseware	Biodegradable Cleaning Products	High	1990	\$220	\$302	\$600,980	\$84,137	\$516,843	\$84,137
USA	VanArsdel	Compostable Food Packaging	Low	1254	\$3	\$380	\$476,520	\$4,765	\$471,755	\$4,765
USA	Proseware	Natural Personal Care Products	Medium	1465	\$224	\$302	\$442,430	\$26,546	\$415,884	\$26,546
USA	Proseware	Sustainable Snack Packaging	Medium	1410	\$120	\$302	\$425,820	\$25,549	\$400,271	\$25,549
Australia	Proseware	Natural Personal Care Products	Medium	1369	\$224	\$302	\$413,438	\$24,806	\$388,632	\$24,806
USA	VanArsdel	Compostable Food Packaging	Medium	1052	\$3	\$380	\$399,760	\$23,986	\$375,774	\$23,986
Canada	VanArsdel	Compostable Food Packaging	Low	980	\$312	\$380	\$372,400	\$3,724	\$368,676	\$3,724
Australia	Proseware	Sustainable Snack Packaging	Medium	1298	\$120	\$302	\$391,996	\$23,520	\$368,476	\$23,520
Australia	VanArsdel	Compostable Food Packaging	None	954	\$3	\$380	\$362,520	\$0	\$362,520	\$0
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Hi Lilly, what can I do for you?

Analyze this quarter's business results and summarize three key trends

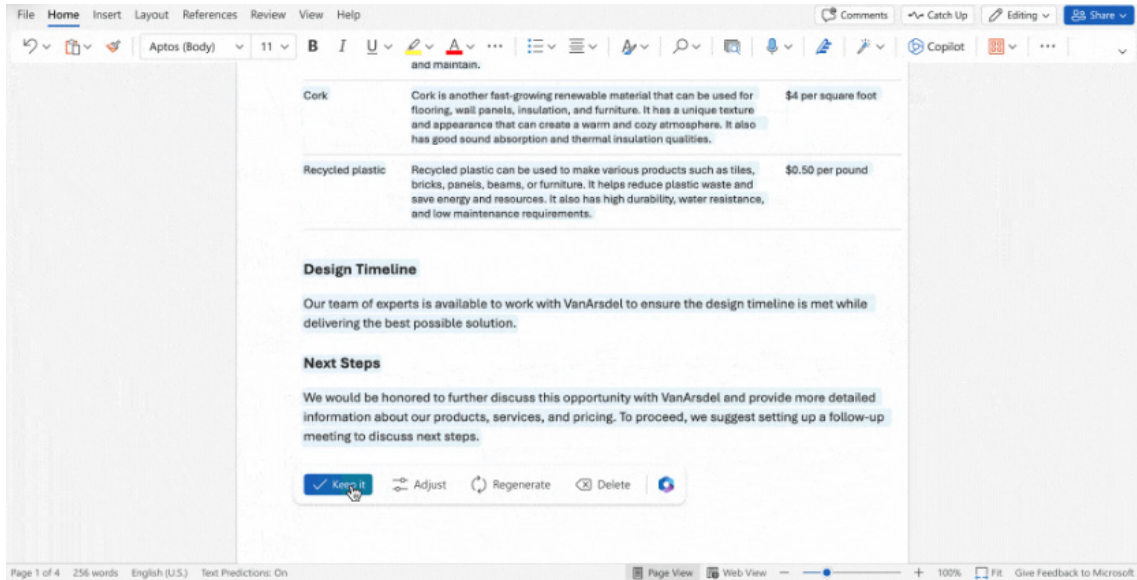
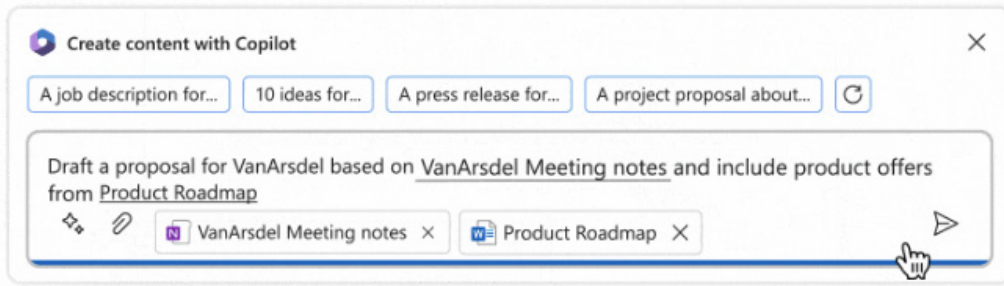
Copilot in Word

Copilot in Word writes, edits, summarises and creates copy as requested. With only a brief prompt, it will create a first draft for you, bringing in information from across your organisation as needed. Copilot can add content to existing documents, summarise text, and rewrite sections or the entire document to make it more concise. You can even get

suggested tones, from professional to passionate and casual to thankful, to help you strike the right note. Copilot can also help you improve your writing with suggestions that strengthen your arguments or smooth inconsistencies (maybe it has even learned so spell “liaise”!!).

Microsoft suggests the following examples:

- Draft a two-page project proposal based on the data from the Budget Forecast document for 2023 and the Sales Forecast spreadsheet
- Make the third paragraph more concise
- Change the tone of the document to be more casual
- Create a one-page draft based on this rough outline.



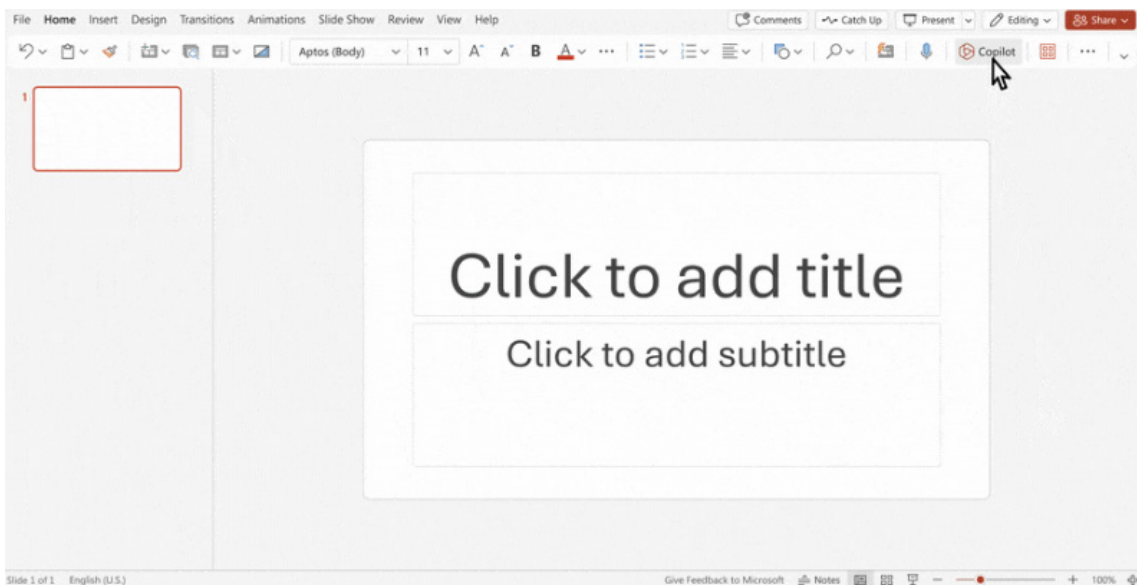
Copilot in PowerPoint

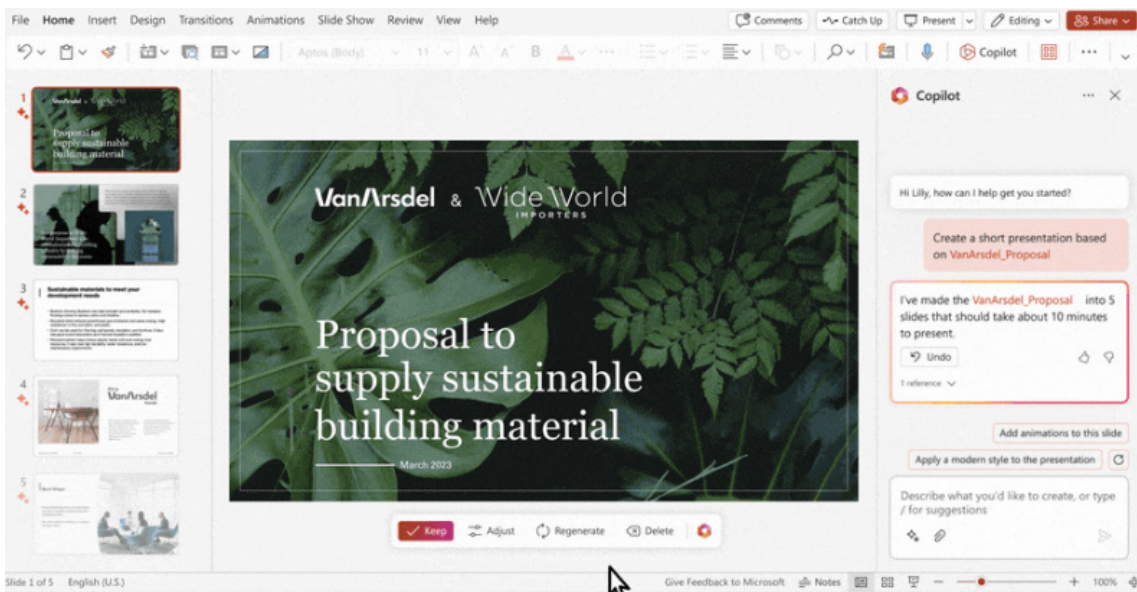
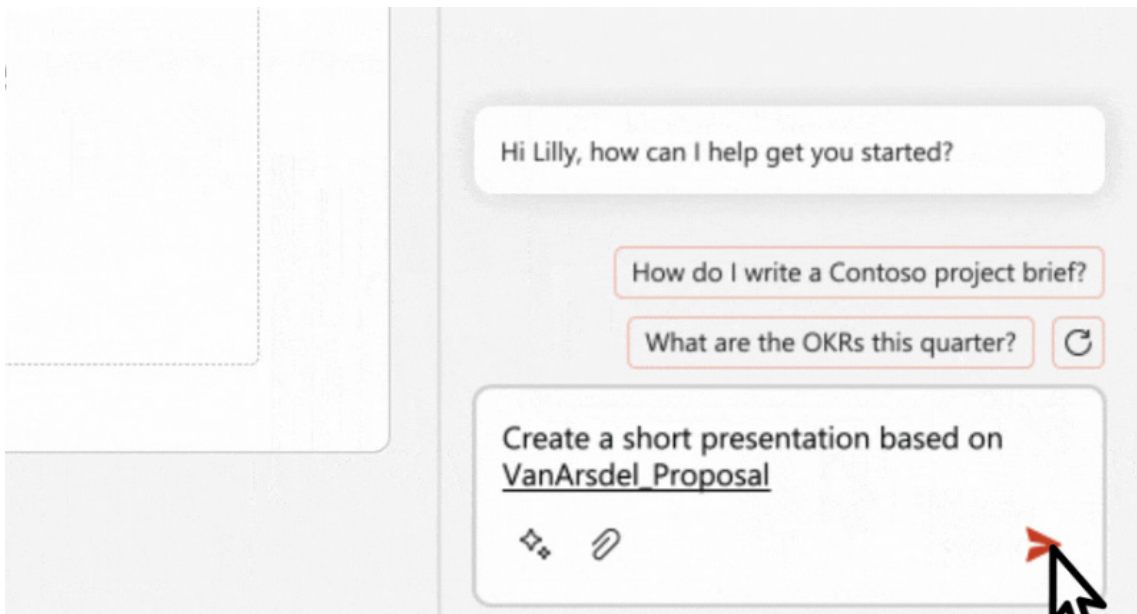
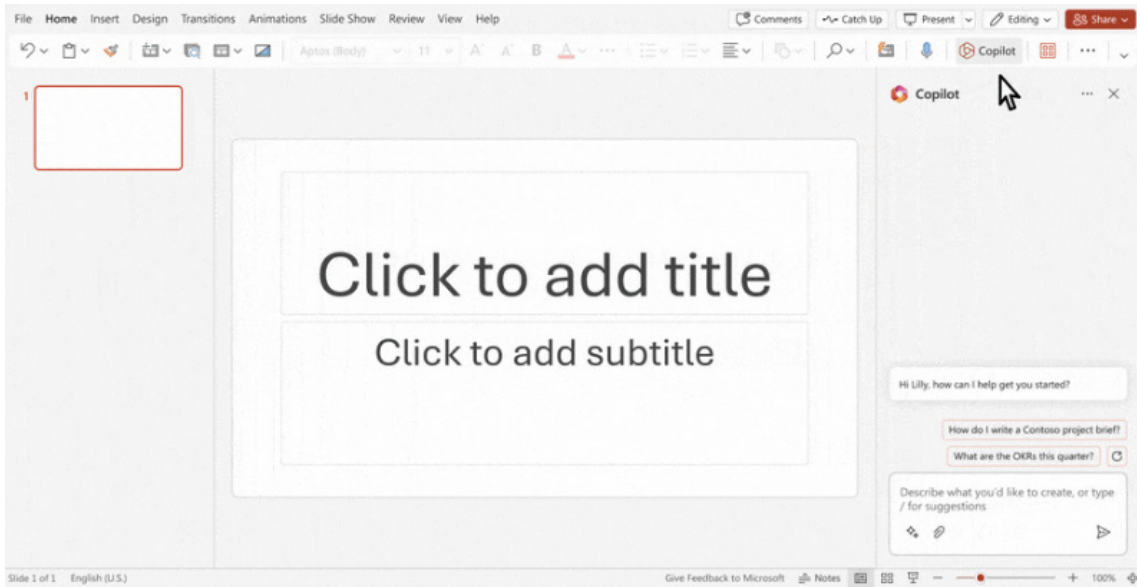
Here, Copilot helps you turn your ideas into presentations. It can transform existing written documents into decks complete with speaker notes and sources or start a new presentation from a simple prompt

or outline. Are we needed anymore!? Lengthy presentations may be condensed at the click of a button and use natural language commands to adjust layouts, reformat text and time animations.

Yet again, here are some suggested examples:

- Create a five-slide presentation based on a Word document and include relevant stock photos
- Consolidate this presentation into a three-slide summary
- Reformat these three bullets into three columns, each with a picture.





Copilot in Other Applications

In Outlook, Copilot can work with your inbox and messages to summarise lengthy email threads, respond to emails quickly or wordsmith emails to sound more professional, and request a summary of unread emails, send out invitations, etc.

In Teams, meetings can be run more effectively, where Copilot can summary outstanding action points, summarise previous conversations, create meeting agenda and summarise discussions.

Business Chat

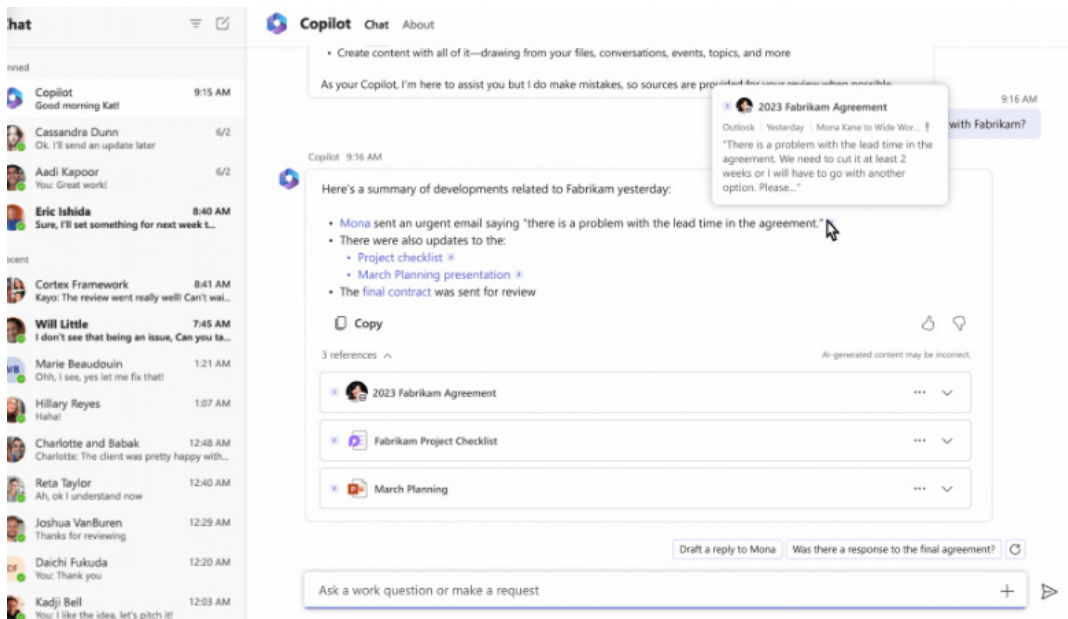
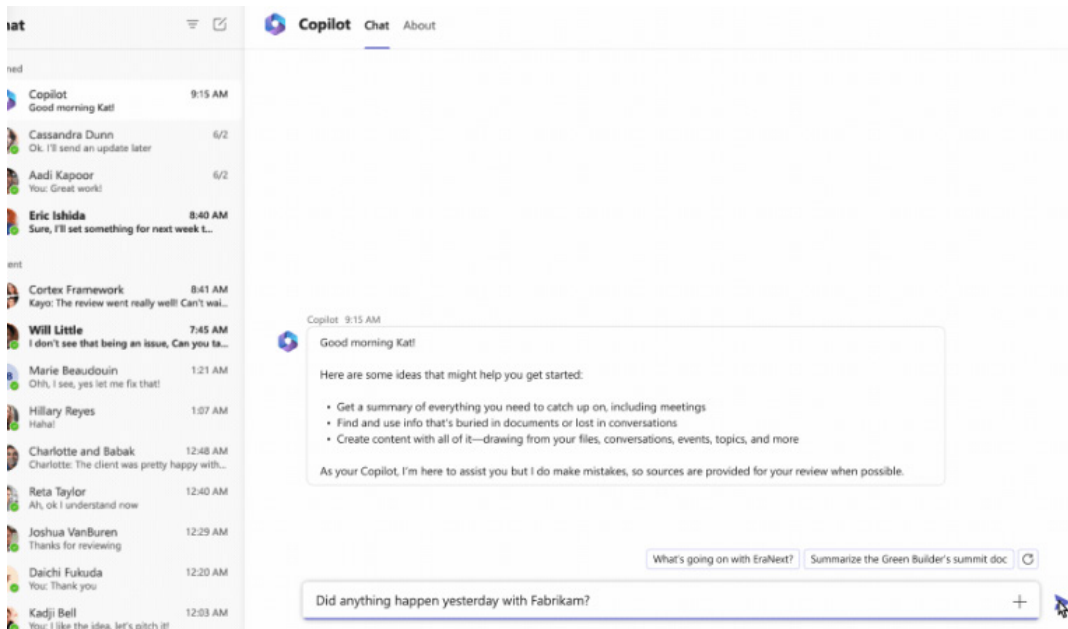
Business Chat is a new experience that works across all your data and apps. As above, it works alongside you, using the power of the Microsoft Graph to bring together data from across your documents, presentations, email, calendar, notes and contacts. You may bring

together information from multiple sources to keep everyone on the team on the same page and moving forward together. As a result, you should spend less time focused on the tools and more time focused on the most important work.

It is slowly being rolled out in Preview in Microsoft Teams.

Examples here might include:

- Summarise the chats, emails and documents about the customer complaint made earlier today
- What is the next milestone on the Invade Mars project? Were there any risks identified? Help me brainstorm a list of some potential mitigations
- Write a new planning overview in the style of the Marketing Guidelines document that contains the planning timeline from the Project Xerxes spreadsheet and incorporates the project list in the email from Shania Twain (OK, I have used a little bit of imagination here...).



Want it..?

No doubt if you have read this far, you want to know exactly where you can get this and how to download it in the next 30 seconds or less. Well, the *announcement* has been made. Currently, Microsoft is testing Microsoft 365 Copilot with 20 customers, including eight in Fortune 500 enterprises. They will be expanding these Previews to customers more broadly in the coming months and industry commentators believe it is likely to roll out in the US first (similar to other new initiatives).

There have already been some interesting debates on the internet though, stemming from Github Copilot. Some are concerned whether the

software is “raiding” copyrighted material out there already. However, various third parties have commented that copyright law has only ever applied to intellectual creations – so where there is no creator, there is no work. This means that machine-generated code like that of GitHub Copilot is not a work under copyright law at all, so it is not a derivative work either. To be clear, this is not SumProduct’s advice, we are merely restating comments made by more learned folk than ourselves.

Whatever, the future’s coming: watch this space!

Beat the Boredom Challenge

With many of us currently “working from home” / quarantined, there are only so Zoom / Teams calls and virtual parties you can make before you reach your (data) limit. Perhaps they should measure data allowance in blood pressure millimetres of mercury (mmHg). To try and

keep our readers engaged, we will continue to reproduce some of our popular **Final Friday Fix** challenges from yesteryear in this and upcoming newsletters. One suggested solution may be found later in this newsletter. Here’s this month’s...

This month’s challenge is to generate the list of the most recent items in a list simply using Excel formulae.

As an example, there is an **Order_Database** data set which contains details of **Customer Name**, **Order Date** and **Order Volume** over the time:

	A	B	C	D	E	F	G	H	I
1	Customer Name	Order Date	Order Volume						
2	Harris	28/01/2021	353				Customer	Jones Financial (Edward Jones)	
3	Avnet	21/01/2021	929						
4	Las Vegas Sands	19/01/2021	479				Last five orders:		
5	Sherwin-Williams	18/01/2021	360				Order Date	Order Volume	
6	Mastercard	13/01/2021	202			1			-
7	Alcoa	13/01/2021	612			2			-
8	Ford Motor	11/01/2021	482			3			-
9	Mastercard	6/01/2021	830			4			-
10	Jones Financial (Edward Jo	5/01/2021	777			5			-
11	Old Republic International	3/01/2021	460				Average		-
12	Owens Corning	3/01/2021	639						
13	Jones Financial (Edward Jo	1/01/2021	480						
14	Ford Motor	31/12/2020	932						
15	Fidelity National Financial	31/12/2020	320						
16	Avnet	31/12/2020	282						
17	Owens & Minor	27/12/2020	620						
18	Intuit	27/12/2020	589						
19	Caterpillar	26/12/2020	424						
20	Markel	25/12/2020	453						
21	Avnet	23/12/2020	629						
22	Ford Motor	23/12/2020	472						
23	Intuit	20/12/2020	219						
24	Charter Communications	18/12/2020	529						
25	Intuit	14/12/2020	403						
26	Fidelity National Financial	12/12/2020	719						

To facilitate the conversation with customers upon placing an order, the operator wants to view the five most recent orders from a given customer. Specifically, when a customer is selected from the list in cell **H2** (see image above), their last five order dates will appear in cells **G6:G10** in descending order, together with the related order volumes.

Can you get the list in cells **G6:G10** in just **two** steps?

Sounds easy? Try it. One solution *just might* be found later in this newsletter – but no reading ahead!

Charts and Dashboards

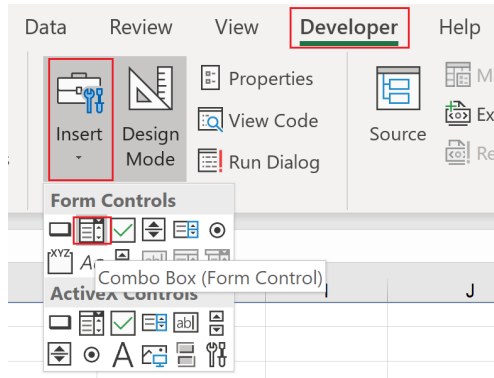
It’s time to chart our progress with an introductory series into the world of creating charts and dashboards in Excel. This month, we again look at interactive charts, this time using Drop-down Lists.

To recap, last newsletter we began considering interactive charts, where we may add a data selection option to charts, for example, through a Check box or a Drop-down List. In last month’s article, we discussed how to create Check Boxes using Form Controls. Now, let’s see how we may create a Drop-down List.

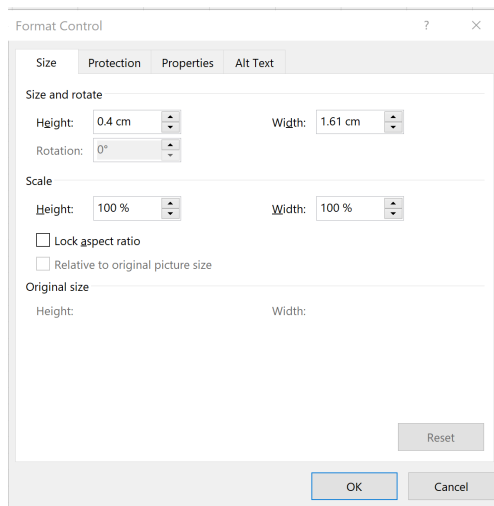
First, in the chart data area, we will add a column, e.g. 'Sales by group', with which we will later build our chart. We will also add a list of **Groups**, with a blank cell at the top (highlighted in green in the image below). Later, we will add a cell link to this.

	D	E	F	G	H	I	J	K
10	Quarter	BizSupplies	Dynamic Attire	Harmonic Sonics	Plumb'n'Stuff	Other	Sales by group	Groups
11	Sep-17	\$ 68,086	\$ 60,464	\$ 61,817	\$ 66,537	\$ 34,551		
12	Dec-17	\$ 72,390	\$ 58,367	\$ 65,308	\$ 72,208	\$ 45,078		BizSupplies
13	Mar-18	\$ 74,836	\$ 61,641	\$ 64,581	\$ 74,450	\$ 46,431		Dynamic Attire
14	Jun-18	\$ 76,904	\$ 65,100	\$ 66,726	\$ 76,040	\$ 46,067		Harmonic Sonics
15	Sep-18	\$ 76,035	\$ 68,089	\$ 67,453	\$ 78,463	\$ 47,343		Plumb'n'Stuff
16	Dec-18	\$ 79,477	\$ 67,600	\$ 73,597	\$ 78,216	\$ 47,904		Other
17	Mar-19	\$ 77,953	\$ 69,062	\$ 72,802	\$ 82,239	\$ 46,795		
18	Jun-19	\$ 81,038	\$ 69,994	\$ 75,983	\$ 83,071	\$ 49,810		

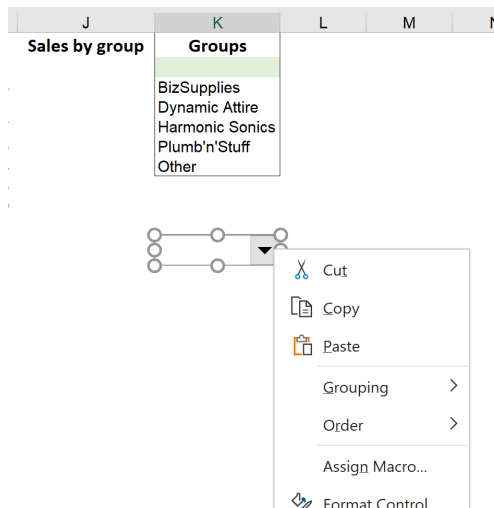
We navigate to the Developer tab on the Ribbon. We choose **Insert -> Form Controls** and click the Combo Box (the second left icon on the top row):



We need to make sure we choose the Combo Box from the 'Form Controls' group, not the 'ActiveX Controls' group – which is for VBA. If you inadvertently choose the wrong version, you will notice that there is no Control tab in the 'Format Control' dialog:



Having selected the Form variant, by holding the **ALT** key and click on a cell in the worksheet, a box with an arrow icon will appear that may be snapped to grid:



Next, right-click on the icon on the work sheet and click 'Format Control...'. In the Control tab, to define the 'Input range', we will select the list of groups in cell **K12:K16**, and refer the 'Cell link' to the blank green cell, which is cell **K11**.

	D	E	F	G	H	I	J	K
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Format Object

Size Protection Properties Alt Text Control

Input range: ↑

Cell link: ↑

Drop down lines:

2-D shading

OK Cancel

Then, we will resize the arrow box (if necessary). As we choose one item from the list, note that the cell link will reflect its index number (i.e. position in the list):

	D	E	F	G	H	I	J	K
11	Sep-17	\$ 68,086	\$ 60,464	\$ 61,817	\$ 66,537	\$ 34,551		1
12	Dec-17	\$ 72,390	\$ 58,367	\$ 65,308	\$ 72,208	\$ 45,078		
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Now, we need to match the sales figures corresponding to the group that we have chosen from the drop-down menu. This can be done easily using the **INDEX** function. The 'Sales by group' cell will be the index result from the corresponding range chosen; the array in this example has only

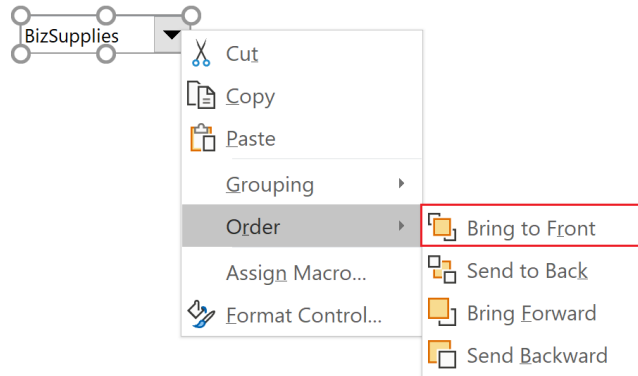
one row, so only one reference is required, whether the range were to consist of one row or one column. Here, if we choose **Biz Supplies** from the list, the cell link shows number one [1] – as this is the order of **Biz Supplies** item in the list, this will also be the column number to index.

J11 fx =INDEX(\$E11:\$I11,,\$K\$11)

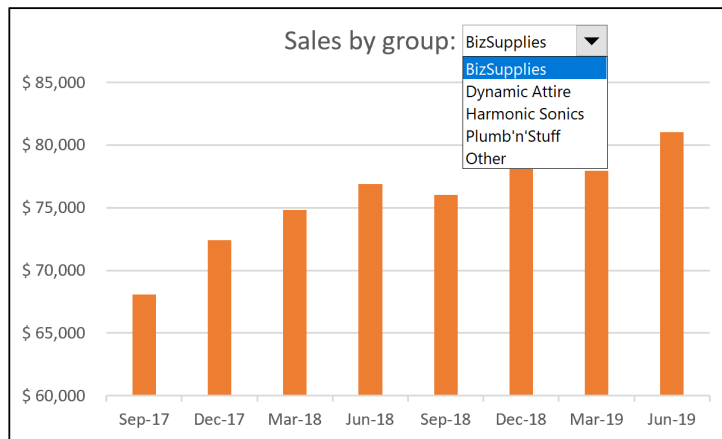
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BizSupplies

Then we can build a chart on the 'Sales by group' column based on Quarters. We may also need to bring the drop-down box to front to insert to the chart. To insert the Drop-down List, just drag the icon to the chart:



This chart is now interacted accordingly to our group selection using the Drop-down List.



More next month...

Visual Basics

We thought we'd run an elementary series going through the rudiments of Visual Basic for Applications (VBA) as a springboard for newer users. This month we discuss how to get the intended format.

It's easy enough to get on a cell's case as we explored last month, but what if we wanted to find a cell that is formatted in a particular way? Like cells that have been bolded or have a specific background colour?

This is where the **SearchFormat** parameter comes in. This is a Boolean parameter that tells the **Find** method to search a particular format. But how do we set the format?

This is where we have to declare the **FindFormat** object. **FindFormat** is a special object property of the **Application** where you may set particular

formatting details to search in the **Range.Find** method. All we need to do is set the **FindFormat** properties as if we were setting the properties of any given **Range**.

For example, if we wanted to set the text to be bold, we might use

```
Application.FindFormat.Font.Bold = True
```

Let's review the search range we've been using the last few months:

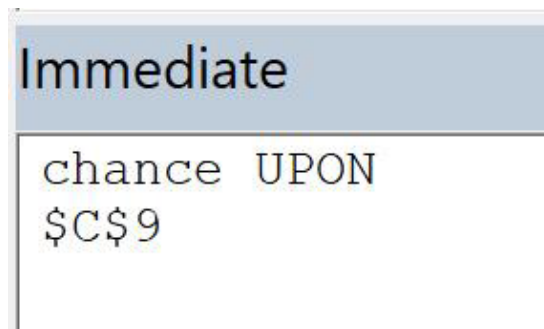
	A	B	C	D	E
1	detect	turn up	observe	come up with	scare up
2	discover	uncover	perceive	dig up	smoke out
3	encounter	unearth	pinpoint	fall in with	stumble upon
4	identify	collar	recognize	ferret out	trip on
5	locate	corral	sight	happen upon	reencounter
6	meet	descry	arrive at	lay fingers on	
7	notice	discern	bring to light	light upon	
8	recover	distinguish	bump into	make out	
9	spot	espy	chance UPON	run across	
10	strike	expose	come across	run into	

In our range that we've been using, some of the cells have been highlighted yellow. The RGB (red, green, blue) code for that colour is R = 255, G = 255 and B= 0 (note this information can be found by going into the "Custom" colours and it will show the RGB code for the chosen cell). To search for that particular format, we could use

```
Application.FindFormat.Interior.Color = RGB(255, 255, 0)
```

So how would this apply in our Macro?

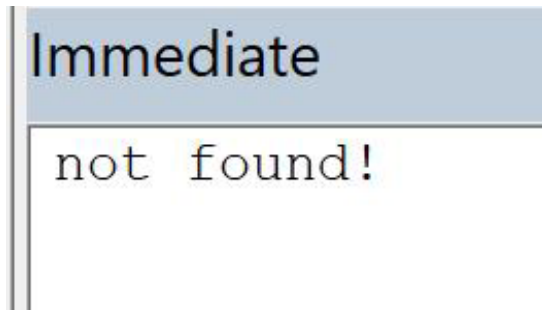
```
Sub FindFormat()  
    Dim searchRange As Range  
    Set searchRange = Range("A1:E10")  
    Application.FindFormat.Interior.Color = RGB(255, 255, 0)  
    Dim foundrange As Range  
    Set foundrange = searchRange.Find("upon", Lookat:=xlPart,  
    MatchCase:=False, searchformat:=True)  
    If foundrange Is Nothing Then  
        Debug.Print "not found!"  
    Else  
        Debug.Print foundrange  
        Debug.Print foundrange.Address  
    End If  
End Sub
```



Easy!

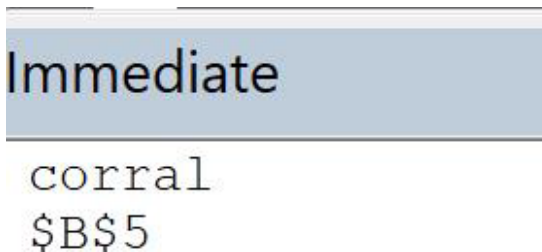
Now we may add multiple formatting details to a cell. We could do this:

```
Sub FindFormat()  
    Dim searchRange As Range  
    Set searchRange = Range("A1:E10")  
    Application.FindFormat.Interior.Color = RGB(255, 255, 0)  
    Application.FindFormat.Font.Color = RGB(255, 0, 0)  
    Dim foundrange As Range  
    Set foundrange = searchRange.Find("upon", Lookat:=xlPart,  
    MatchCase:=False, searchformat:=True)  
    If foundrange Is Nothing Then  
        Debug.Print "not found!"  
    Else  
        Debug.Print foundrange  
        Debug.Print foundrange.Address  
    End If  
End Sub
```



There is a cell formatted in that particular way despite there is no cell with the word “upon” in the search range. We can easily find just the format by giving it an empty string, *i.e.* "" to search for instead:

```
Sub FindFormat()  
    Dim searchRange As Range  
    Set searchRange = Range("A1:E10")  
    Application.FindFormat.Interior.Color = RGB(255, 255, 0)  
    Application.FindFormat.Font.Color = RGB(255, 0, 0)  
    Dim foundrange As Range  
    Set foundrange = searchRange.Find("", Lookat:=xlPart,  
    MatchCase:=False, searchformat:=True)  
    If foundrange Is Nothing Then  
        Debug.Print "not found!"  
    Else  
        Debug.Print foundrange  
        Debug.Print foundrange.Address  
    End If  
End Sub
```



There are a lot of different ways we could format a cell, but the one thing the **FindFormat** object will not allow us to set is a particular **Style**. Since we may assign multiple properties in the **Application.FindFormat**, it is easy to reset in order to search a different format later on with the simple line:

```
Application.FindFormat.Clear
```

That's it for the **Find** method. More next month.

Power Pivot Principles

We continue our series on the Excel COM add-in, Power Pivot. This month, we consider a calculation that is a little more awkward than you might think at first...

CAGR stands for **Compound Annual Growth Rate**. It describes the rate at which an investment would have grown over several years if it had grown at the same rate every year on a compounding, rather than simple, basis.

The CAGR metric is calculated using the following formula:

$$CAGR = \left(\frac{\text{Ending Value}}{\text{Beginning Value}} \right)^{\left(\frac{1}{\# \text{ of Years}} \right)} - 1$$

If we were to fit this entire formula into a single measure it may get messy and confusing for other users, so let's step it out.

We will need to create several measures to calculate the individual pieces the CAGR formula. Of course, this is not the only way to calculate CAGR in Power Pivot, but this is the way we've decided to go about it. Therefore, let's break it down: we will need the following measures to calculate CAGR:

1. a measure to retrieve the **First Year** in the data set
2. a measure to retrieve the **Last Year** in the data set
3. a measure to calculate the **Number of Years** between the **First Year** and **Last Year** in the data set
4. a measure to aggregate the **Sales** in the data set
5. a measure to calculate the **Sales in the First Year** of the data set
6. a measure to calculate the **Sales in the Last Year** of the data set
7. finally, a measure to calculate **CAGR**.

The **First Year** measure is calculated as follows:

`=MIN('Calendar'[Year])`

The screenshot shows the 'Measure' dialog box with the following details:

- Table name: Sales Table
- Measure name: First Year
- Description: (empty)
- Formula: `=MIN('Calendar'[Year])`
- Formatting Options: Category: General
- Buttons: OK, Cancel

The **Last Year** measure is very similar:

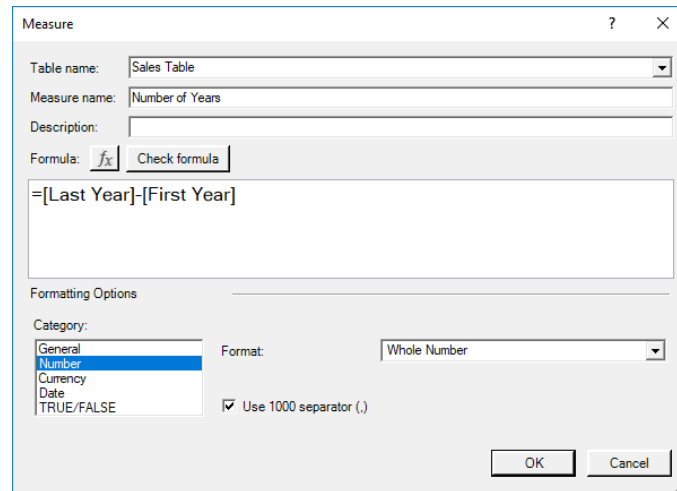
`=MAX('Calendar'[Year])`

The screenshot shows the 'Measure' dialog box with the following details:

- Table name: Sales Table
- Measure name: Last Year
- Description: (empty)
- Formula: `=MAX('Calendar'[Year])`
- Formatting Options: Category: General
- Buttons: OK, Cancel

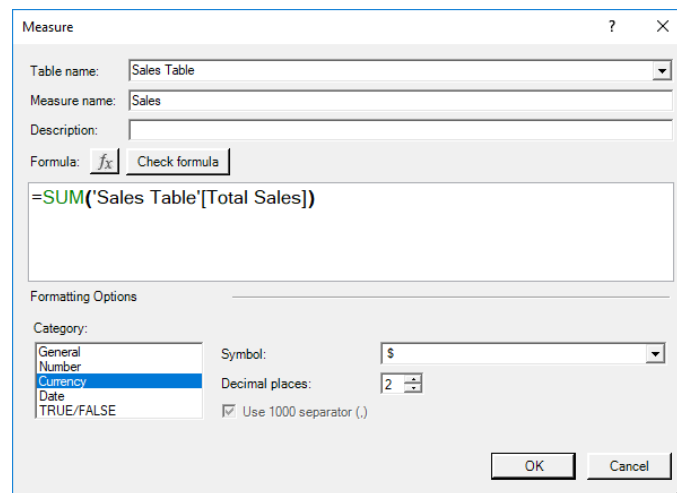
The **Number of Years** measure is simply calculated as the difference between the two years. Unlike calculating dates, you need to resist the urge of adding one to this calculation as there is only one year's growth between the first year and the next year, etc.

- `= [Last Year] - [First Year]`



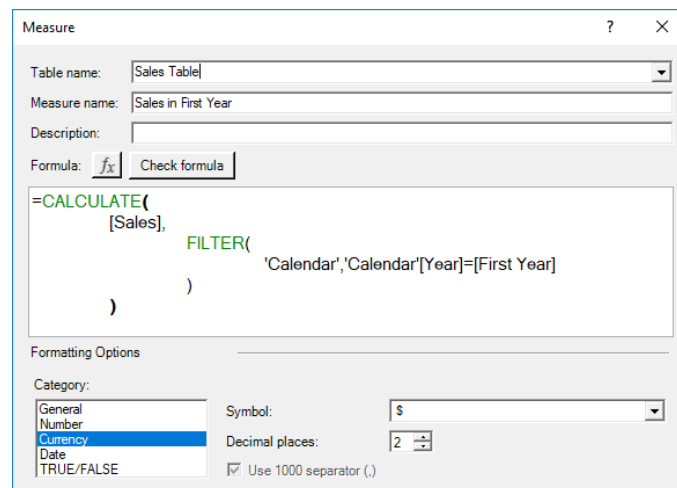
The sales aggregation measure is given by **Sales**:

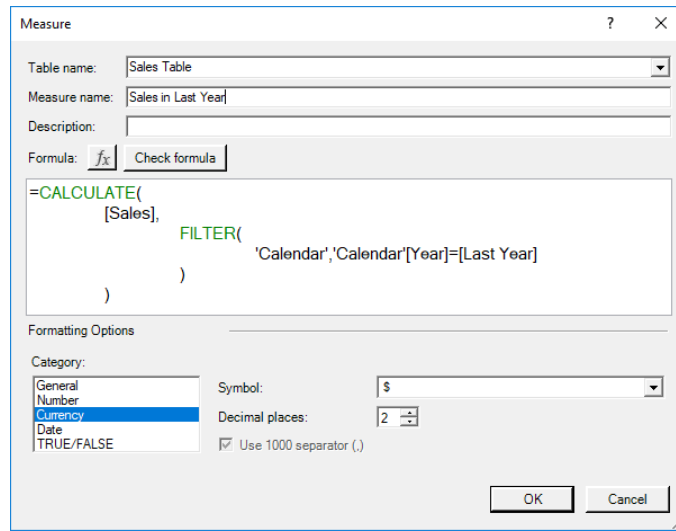
`=SUM('Sales Table'[Total Sales])`



To calculate the **Sales in First Year** measure:

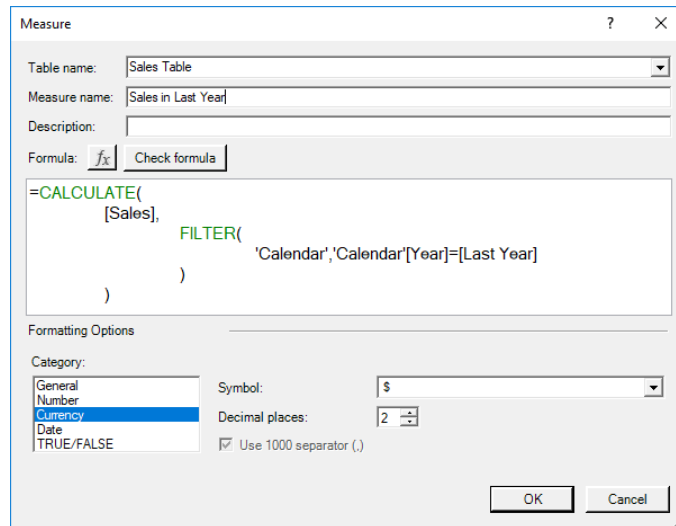
`=CALCULATE([Sales], FILTER('Calendar', 'Calendar'[Year]=[First Year]))`



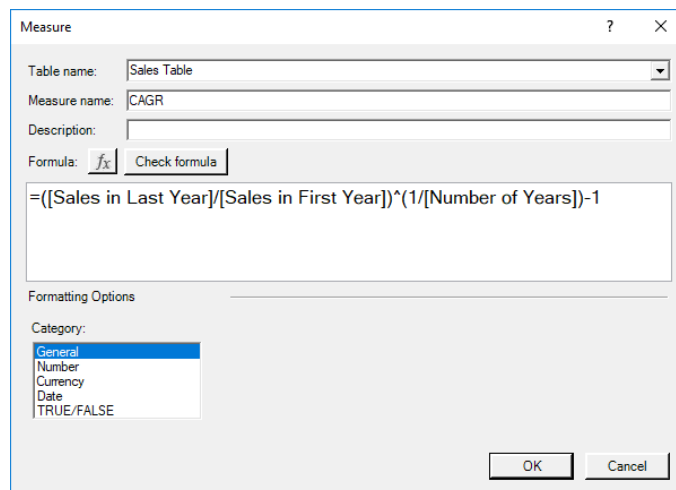


There is therefore no surprise (hopefully!) that **Sales in Last Year** measure is calculated as follows:

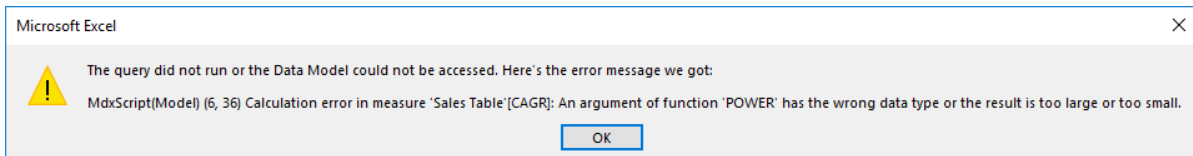
```
=CALCULATE(
    [Sales],
    FILTER(
        'Calendar','Calendar'[Year]=[Last Year]
    )
)
```



The **CAGR** measure is thus given by:

$$=([\text{Sales in Last Year}]/[\text{Sales in First Year}]^{1/[\text{Number of Years}]}-1$$


This all seems to make sense. That should be it: let's create the PivotTable. However, trying to plot our CAGR measure on a PivotTable we get the following message:



Something is not right! Let's plot the individual measures onto a PivotTable to see if we can figure it out:

	A	B	C	D	E	F
1						
2		Row Labels	First Year	Last Year	Sales	Number of Years
3		2018	2018	2018	\$16,136,530.08	0
4		2019	2019	2019	\$19,102,751.42	0
5		2020	2020	2020	\$21,489,979.62	0
6		2021	2021	2021	\$23,644,270.20	0
7		Grand Total	2018	2021	\$80,373,531.32	3
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						

It appears that our **First Year** and **Last Year** measures aren't working as we intended, hence causing our **Number of Years** measure to return with zero [0] for every year. This causes a division by zero error in our **CAGR** measure.

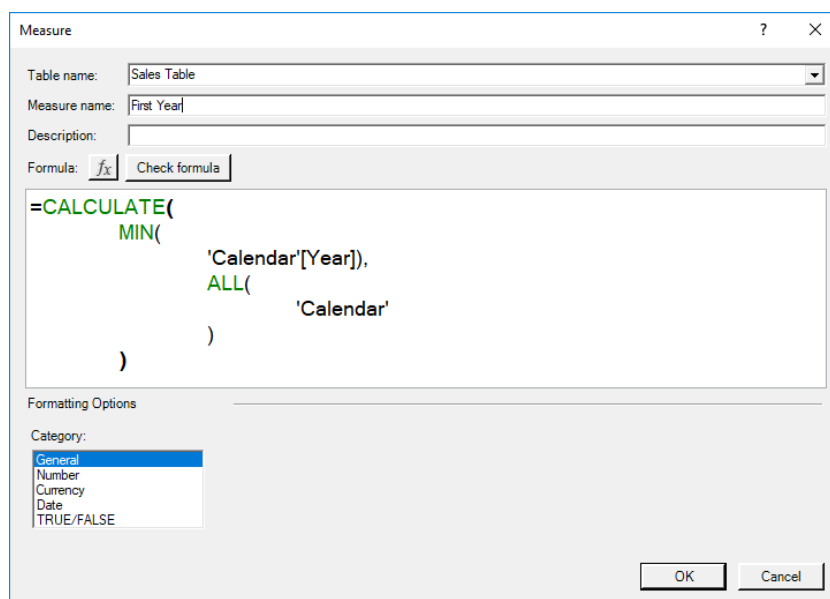
How do we fix this?

The first and last year measures return with the row's first and last years. This is because these measures are subject to the PivotTable row filters. We are going to have to tweak the measures for them to consider the entire range of data, *despite* these row filters.

In this case we will have to use the **ALL** function.

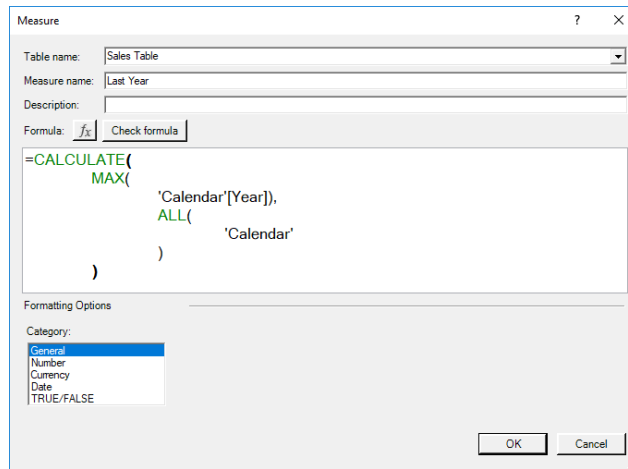
We have to modify the first and last year measures. The **First Year** measure should be revised as follows:

```
=CALCULATE(
  MIN(
    'Calendar'[Year]),
  ALL(
    'Calendar'
  )
)
```



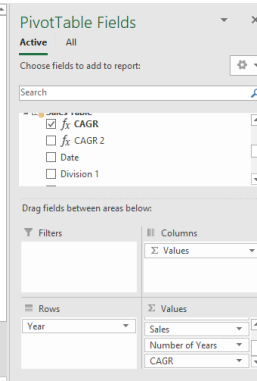
Similarly, the **Last Year** measure should be adapted too:

```
=CALCULATE(
    MAX(
        'Calendar'[Year]),
    ALL(
        'Calendar'
    )
)
```



Our **CAGR** measure now calculates on the PivotTable:

Row Labels	First Year	Last Year	Sales	Number of Years	CAGR
2018	2018	2021	\$16,136,530.08	3	13.58%
2019	2018	2021	\$19,102,751.42	3	13.58%
2020	2018	2021	\$21,489,979.62	3	13.58%
2021	2018	2021	\$23,644,270.20	3	13.58%
Grand Total	2018	2021	\$80,373,531.32	3	13.58%

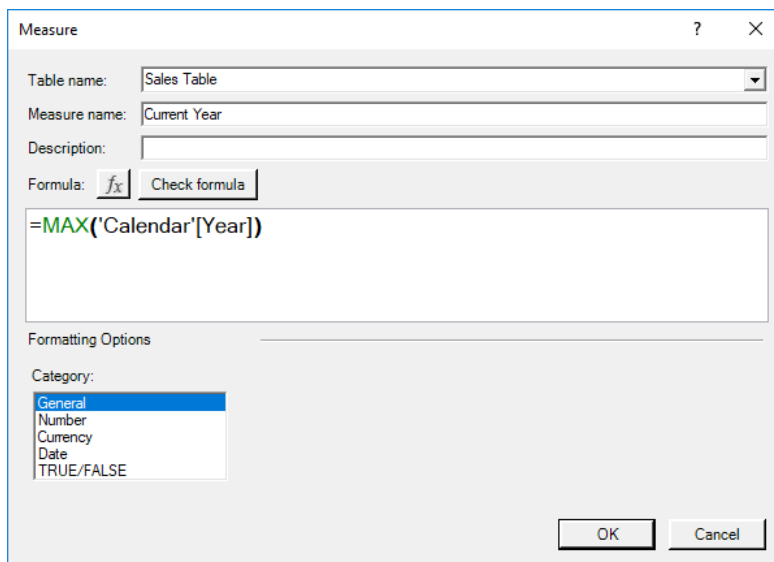


Great, we finally have a working **CAGR** measure! Unfortunately, the measure only calculates the CAGR for the last year, what if we want the progressive CAGR for each year?

The reason why our **CAGR** formula is not calculating dynamically is

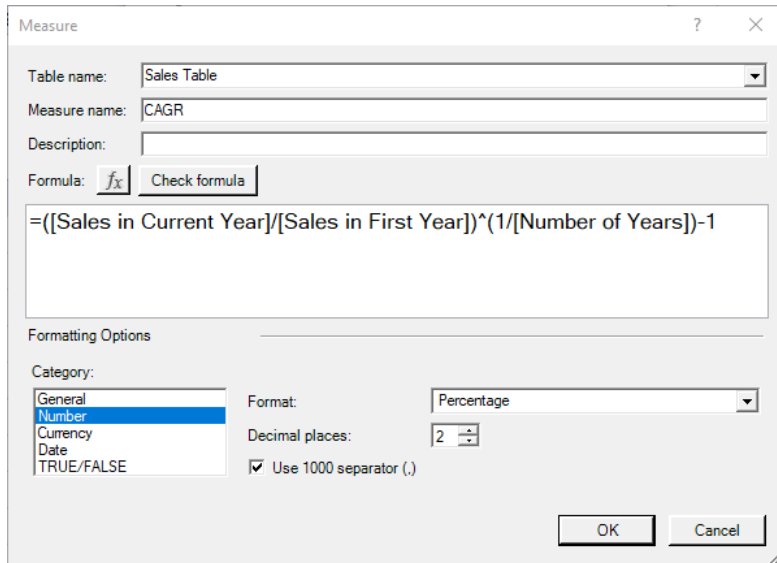
because we are using the **Last Year** measure, which is currently set to retrieve the last year in our data set. To avoid confusion, we are going to create a measure that retrieves the current year called **Current Year**:

```
=MAX('Calendar'[Year])
```



Now we modify our **CAGR** measure to use the **Current Year** measure:

$=([Sales\ in\ Current\ Year]/[Sales\ in\ First\ Year])^{(1/[Number\ of\ Years])-1}$



Measure

Table name: Sales Table

Measure name: CAGR

Description:

Formula: $=[Sales\ in\ Current\ Year]/[Sales\ in\ First\ Year]^{(1/[Number\ of\ Years])-1}$

Formatting Options

Category: Number

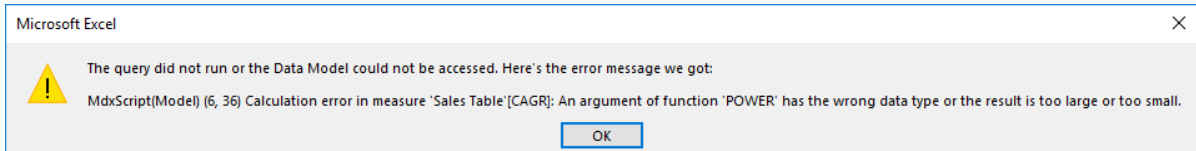
Format: Percentage

Decimal places: 2

Use 1000 separator (.)

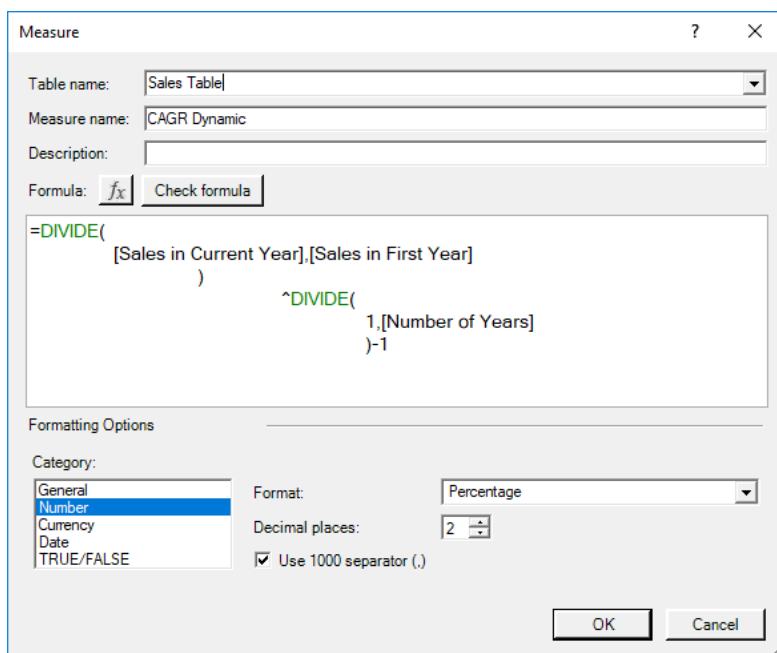
OK Cancel

However, attempting to put our **CAGR** measure in the PivotTable will result in this error:



This is because the number of years for the 2018 period is zero [0], and we can't divide by zero. In this scenario, we should use the **DIVIDE** function to create our **CAGR Dynamic** new-and-improved measure. You may recall the **DIVIDE** function from last month's newsletter!

$=DIVIDE([Sales\ in\ Current\ Year],[Sales\ in\ First\ Year])^{DIVIDE(1,[Number\ of\ Years])-1}$



Measure

Table name: Sales Table

Measure name: CAGR Dynamic

Description:

Formula: $=DIVIDE([Sales\ in\ Current\ Year],[Sales\ in\ First\ Year])^{DIVIDE(1,[Number\ of\ Years])-1}$

Formatting Options

Category: Number

Format: Percentage

Decimal places: 2

Use 1000 separator (.)

OK Cancel

The **DIVIDE** function manages our division by zero problem by returning with **BLANK()** when the denominator is zero. Therefore, this gives us the dynamic CAGR calculation we require:

	A	B	C	D	E
1					
2		Row Labels	Sales	CAGR Dynamic	
3		2018	\$16,136,530.08	0.00%	
4		2019	\$19,102,751.42	18.38%	
5		2020	\$21,489,979.62	15.40%	
6		2021	\$23,644,270.20	13.58%	
7		Grand Total	\$80,373,531.32	70.78%	
8					
9					
10					
11					
12					
13					
14					
15					
16					

More *Power Pivot Principles* next month.

Power Query Pointers

Each month we'll reproduce one of our articles on Power Query (Excel 2010 and 2013) / Get & Transform (Office 365, Excel 2016 and 2019) from www.sumproduct.com/blog. If you wish to read more in the meantime, simply check out our Blog section each Wednesday. This month, we review some useful ways to manipulate dates in **M**.

This month, we are going to consider various **Date() M** functions that can be used to create dates from an existing date, for example, by adding days or weeks to the original date. To this end, if you read this nicely, we may even provide an example for each function.

Date.AddDays

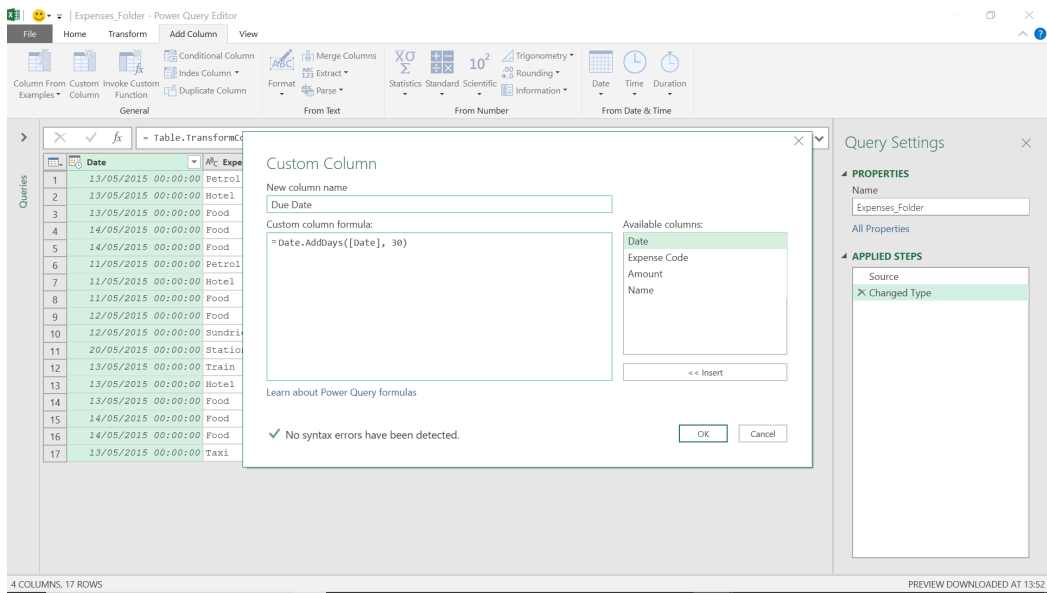
Date.AddDays(datetime as datetime, days as number)

This function returns a Date / DateTime / DateTimeZone value with the day portion incremented by the number of **days** provided. It also handles incrementing the month and year portions of the value as appropriate.

non-existent salespeople. It is in their contracts that they will be reimbursed within 30 days of an expense being incurred, so we need to calculate when this date will be.

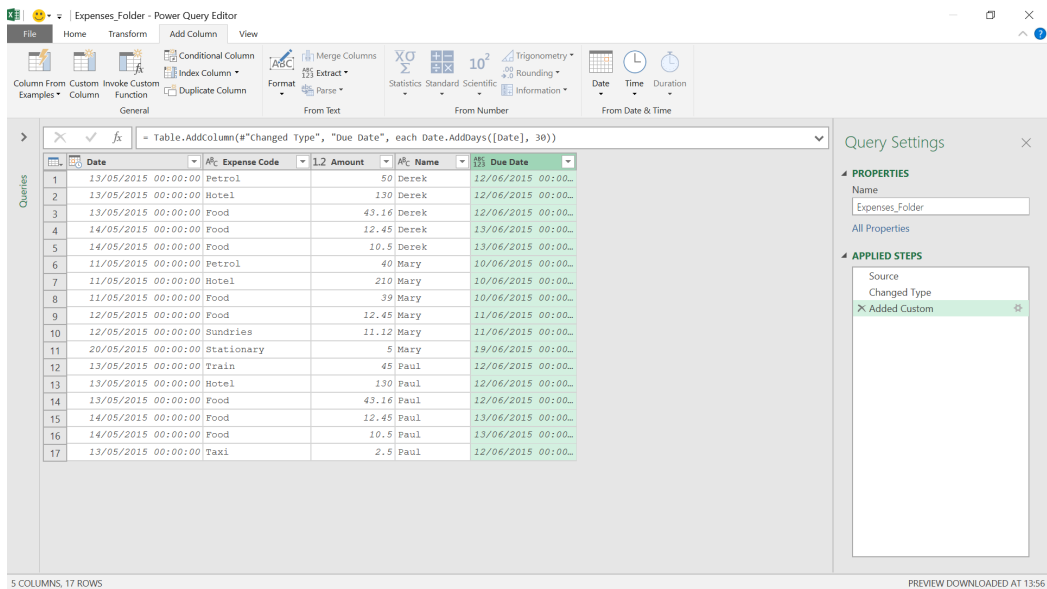
As you may see below, we have some expense data from our reliably

In 'Custom Column' on the 'Add Column' tab, let's create a new column.



The M formula used is

= Date.AddDays([Date], 30)



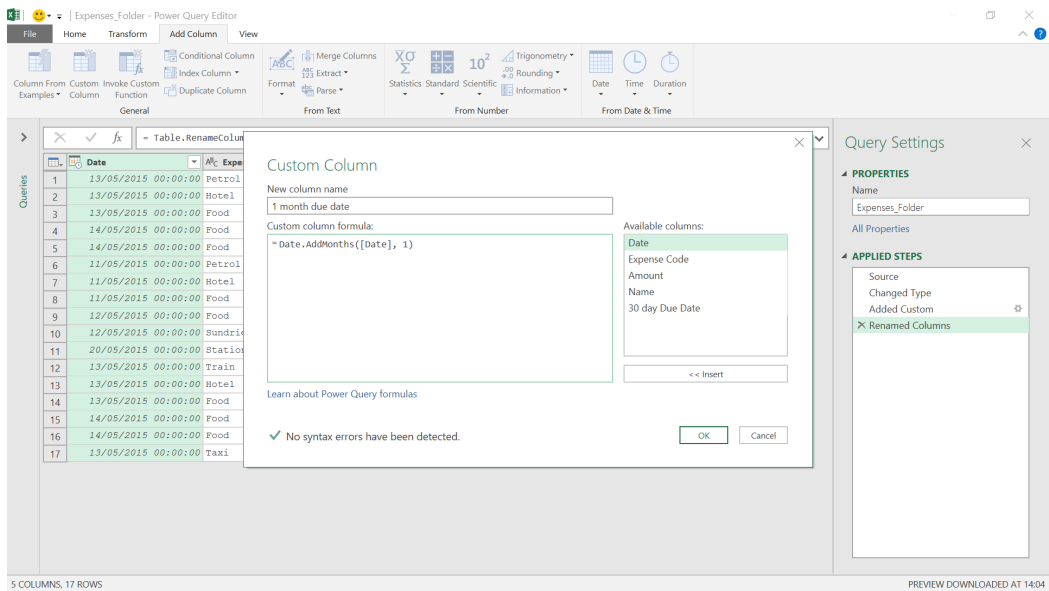
We can now see the deadline of when each expense should be paid.

Date.AddMonths

Date.AddMonths(datetime as datetime, n as number) as nullable datetime

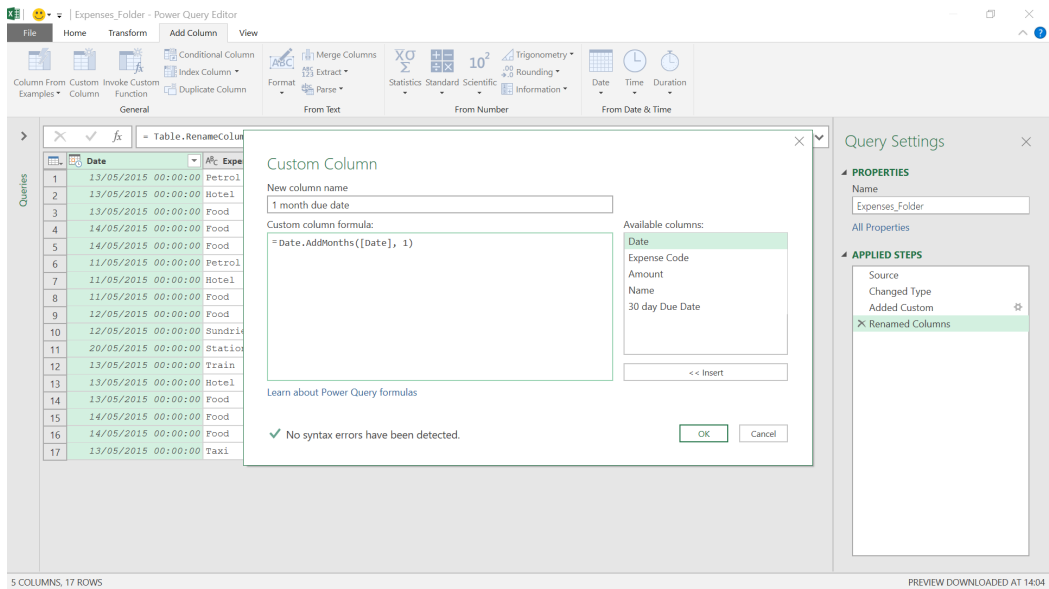
This returns a DateTime value with the month portion incremented by n months.

If the salespeople's contracts showed that they must be paid for their expenses within a month of incurring them, we could use this M function to calculate the due date, viz.



The M formula used here is

= Date.AddMonths([Date], 1)



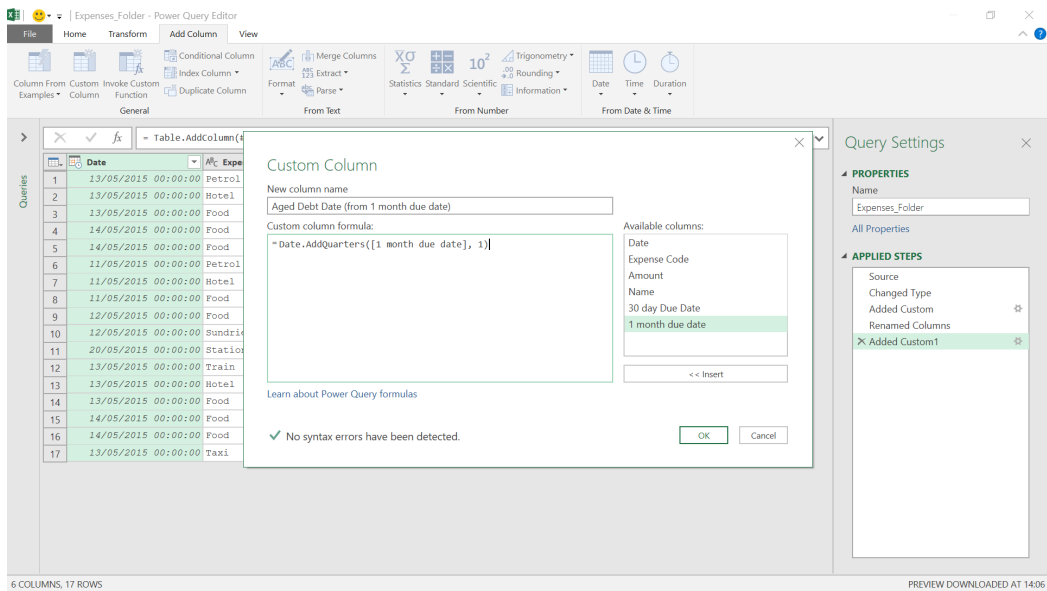
The new due date has been calculated correctly.

Date.AddQuarters

Date.AddQuarters(datetime as datetime, quarters as number) as datetime

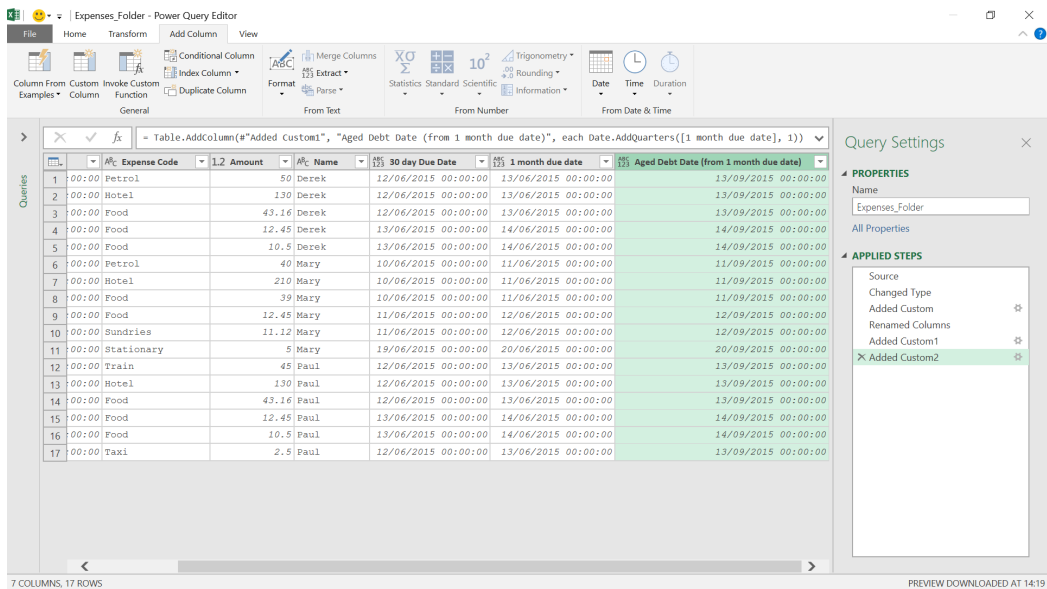
This function returns a Date / DateTime / DateTimeZone value incremented by the number of **quarters** provided. Each quarter is defined as a duration of three months. It also handles incrementing the year portion of the value as appropriate.

We have decided that the payment will be marked as “aged” once we reach the same position in the next quarter. To determine the date this will happen, let’s add a quarter to our due date:



The M formula here is

= Date.AddQuarters([1 month due date], 1)



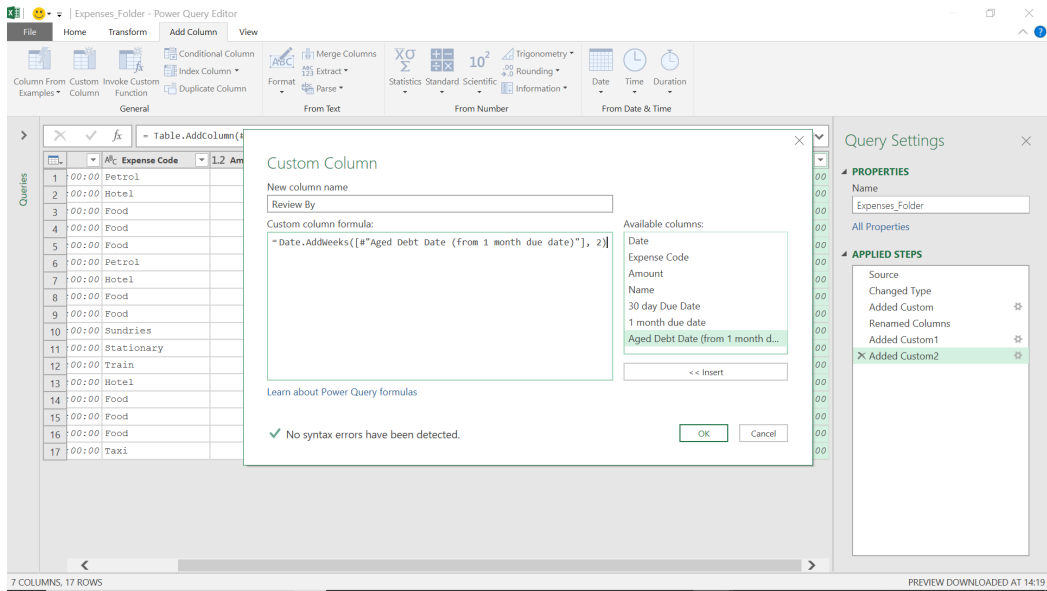
The aged debt date has been calculated correctly.

Date.AddWeeks

Date.AddQuarters(datetime as datetime, quarters as number) as datetime

This returns a Date / DateTime / DateTimeZone value incremented by the number of **weeks** provided. Each week is defined as a duration of seven days. It also handles incrementing the month and year portions of the value as appropriate.

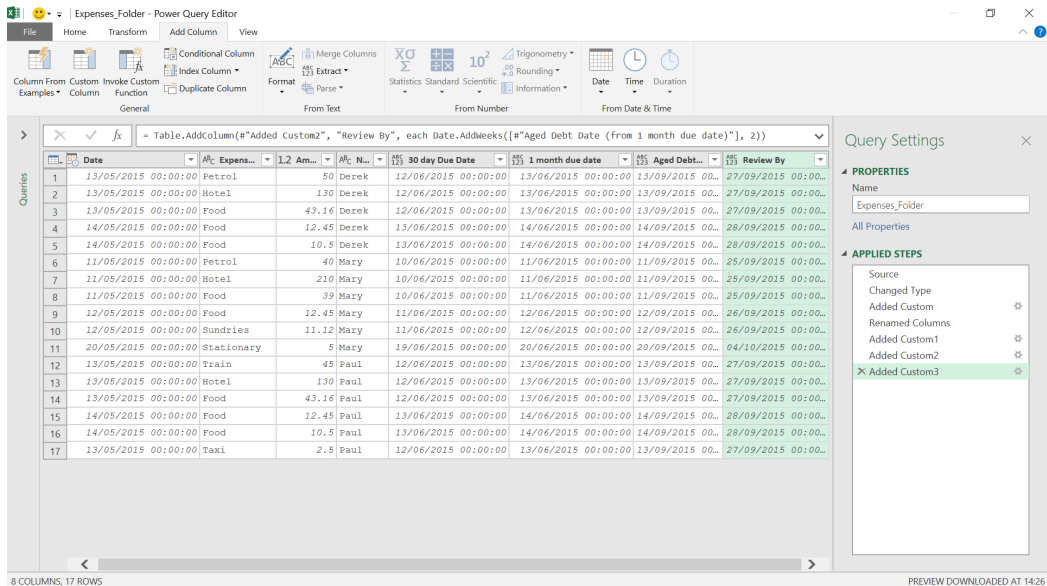
We may also increment the date by a number of weeks, so we'll use this functionality to create a date to review the expense payment.



The M formula used here is

= Date.AddWeeks([#"Aged Debt Date (from 1 month due date)"], 2)

Therefore, we will review if the payment has been made two [2] weeks after it becomes an aged debt.

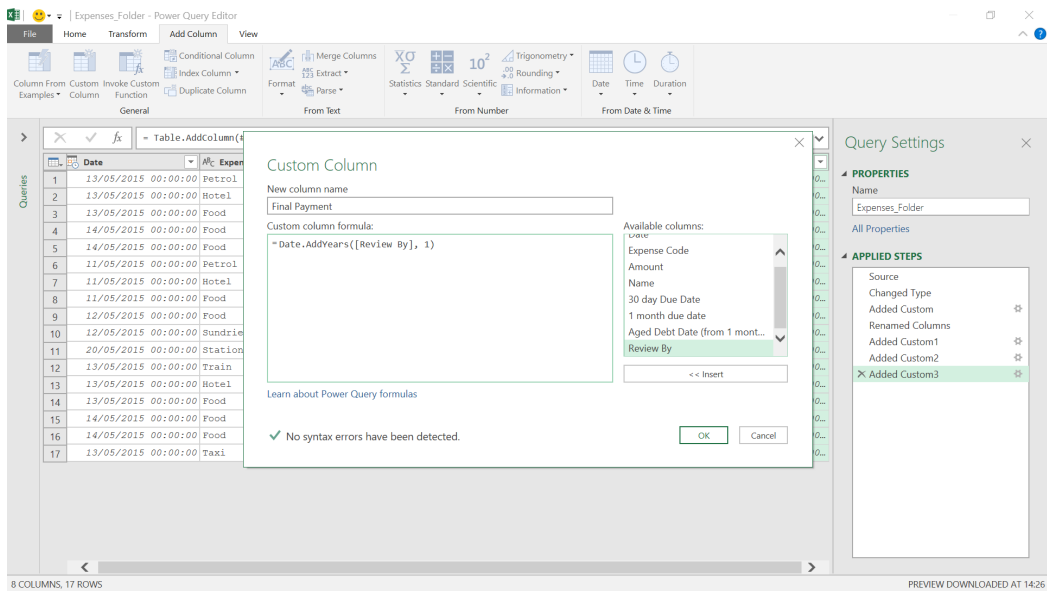


We can now see the review date.

Date.AddYears

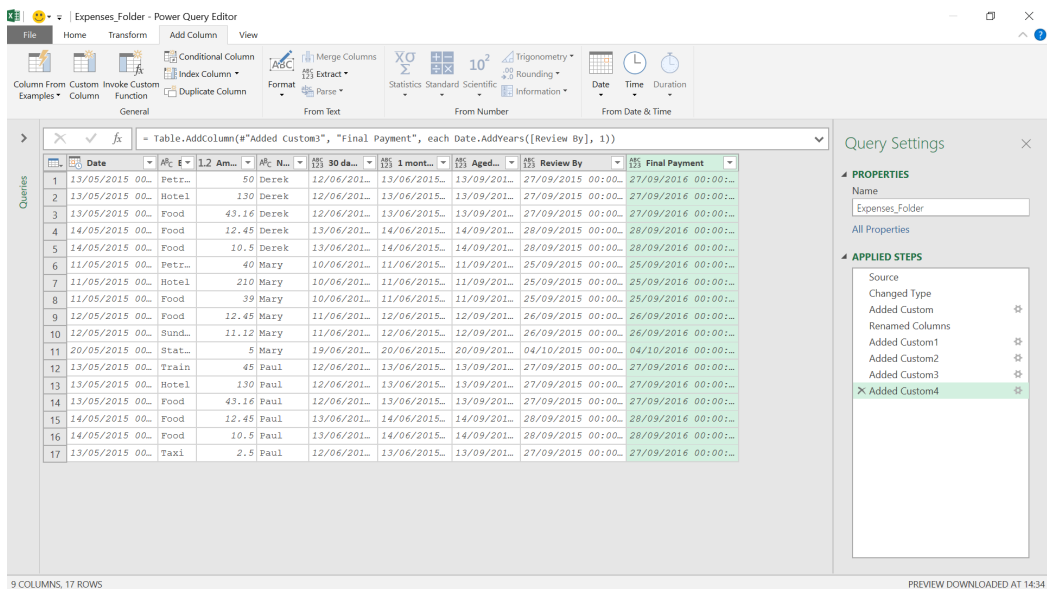
Date.AddYears(datetime as datetime, years as number) as datetime

This function returns a DateTime value with the year portion incremented by **years**. This of course is when I will actually pay the expenses!



The M code used here is

= Date.AddYears([Review By], 1)



We can now see when the poor salespeople will finally be paid their expenses.

More next time.

Power BI Updates

First and foremost, after almost 10 years, support for Windows 8.1 ended on January 10 (why a Tuesday, no one seems to know!). Accordingly, Microsoft will cease supporting Power BI Desktop on Windows 8.1 from the end of January 2024. Thereafter, Power BI Desktop will only be supported on Windows 10 and later editions. Furthermore, the January 2024 release of Power BI Desktop for Report Server will be the last release to support Windows 8.1, and this version will only receive security updates until January 2025 per Microsoft's Modern Lifecycle Policy.

Moving on to the continuation of Power, in this release you'll find On-object interaction, which allows you to right-click on a visual to access the Format pane and updates to the way you can apply slicers on your reports using a new 'Apply all slicers' button. There's also Multiple Audiences in the Power BI app, email subscriptions for scorecards and the General Availability of Storytelling in PowerPoint.

The full list is as follows:

Reporting

- ‘Apply all slicers’ button, ‘Clear all slicers’ button and ‘Optimization presets’ update
- New styling for the Format Pane
- On-object interaction (opt-in) in Preview
- Visual container improvements

Data connectivity

- Google BigQuery and Google BigQuery Azure AD (connector update)
- Azure Databricks and Databricks (connector update)
- Dremio Cloud (connector update)
- FactSet RMS (connector update)
- SurveyMonkey (connector update)

Service

- Storytelling in PowerPoint now Generally Available
- Power BI org app Multiple Audiences now Generally Available
- Announcing new Scanner API scenarios
- Email Subscriptions

Mobile

- Discover external orgs content in your Mobile application
- Grant access on the go

Visualisations

- New visuals in AppSource
- Financial Reporting Matrix v7.0
- Acterys Variance
- Feature Summary for Drill Down Combo PRO
- Gantt Chart by MAQ Software (Premium).

Let’s look at each in turn.

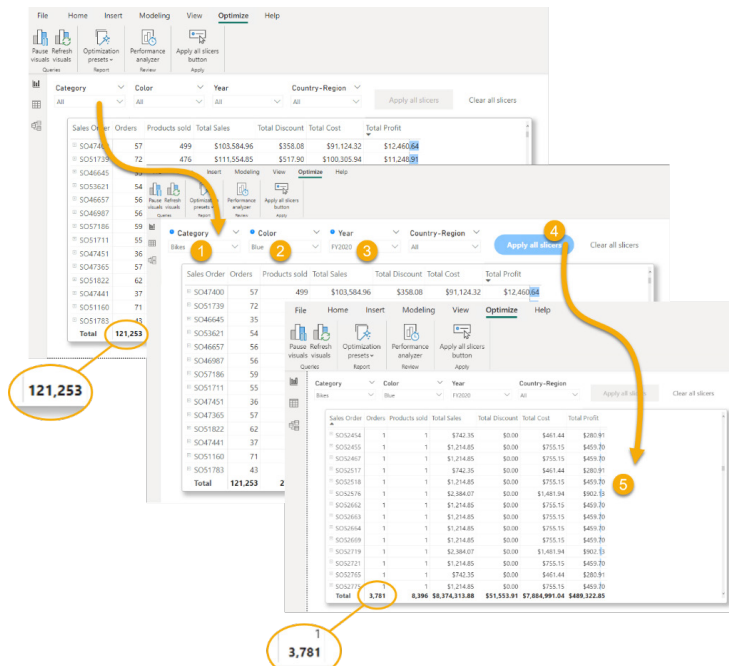
‘Apply all slicers’ button, ‘Clear all slicers’ button and ‘Optimization presets’ update

When Microsoft released the Public Preview of the ‘Optimize’ Ribbon with Pause visuals for authoring reports, many users enquired whether there was a way to allow end users to make slicer selections and have the report visuals only update when they have finished making all slicer selections. And the answer is now yes.

You can add as many of these buttons as you wish to your report page. When at least one of them is visible on the page, all the slicers on your report page will take selection changes but will only apply them to the other report visuals when the button is clicked. If you hide or delete the last ‘Apply all slicers’ button on a report page, then the slicers simply behave like they did before, generally instantly applying the selections as you make selections.

The ‘Apply all slicers’ button may be added in three ways:

1. From the ‘Optimize’ Ribbon -> ‘Apply all slicers’ button
2. From the ‘Insert’ Ribbon -> Buttons -> ‘Apply all slicers’
3. By choosing the ‘Apply all slicers’ action on any existing button in your report.



This ‘Apply all slicers’ button is similar to the existing single ‘Apply’ button on slicers in that they both do not apply the slicer selections to other visuals until you click the button. Unlike the single ‘Apply’ button on slicers, the ‘Apply all slicers’ button will allow you to make selections across multiple slicers and then apply them in one click. For the best query reduction experience with slicers, it’s recommended you use the

‘Apply all slicers’ instead of the single ‘Apply’ button for slicers. The single ‘Apply’ button for slicers is still available and will continue to work on existing reports. The Optimization preset for query reduction has been adjusted to no longer add the single ‘Apply’ button for slicers and recommends the ‘Apply all slicers’ button instead.

Your report is optimized for query reduction



This preset turns off cross-highlighting and cross-filtering. We've added an Apply button to the filter pane so you can apply changes when you're ready. Tip: To further reduce queries, insert an Apply all slicers button to any page.

[Learn more](#)

Got it

Options



DirectQuery
R scripting
Python scripting
Security
Privacy
Regional Settings
Updates
Usage Data
Diagnostics
Preview features
Auto recovery
Report settings

CURRENT FILE

Data Load
Regional Settings
Privacy
Auto recovery
Published dataset set...
Query reduction
Report settings

Reduce number of queries sent by

Disabling cross highlighting/filtering by default

Slicers

Instead of adding an Apply button to each slicer, we recommend adding an **Apply all slicers** button to each page. Select **Insert > Buttons > Apply all slicers** [Learn more](#)

Add an Apply button to each individual slicer (not recommended)

Filters

- Instantly apply basic filter changes
 Add Apply buttons to all basic filters to apply changes when you're ready
 Add a single Apply button to the filter pane to apply changes at once

OK

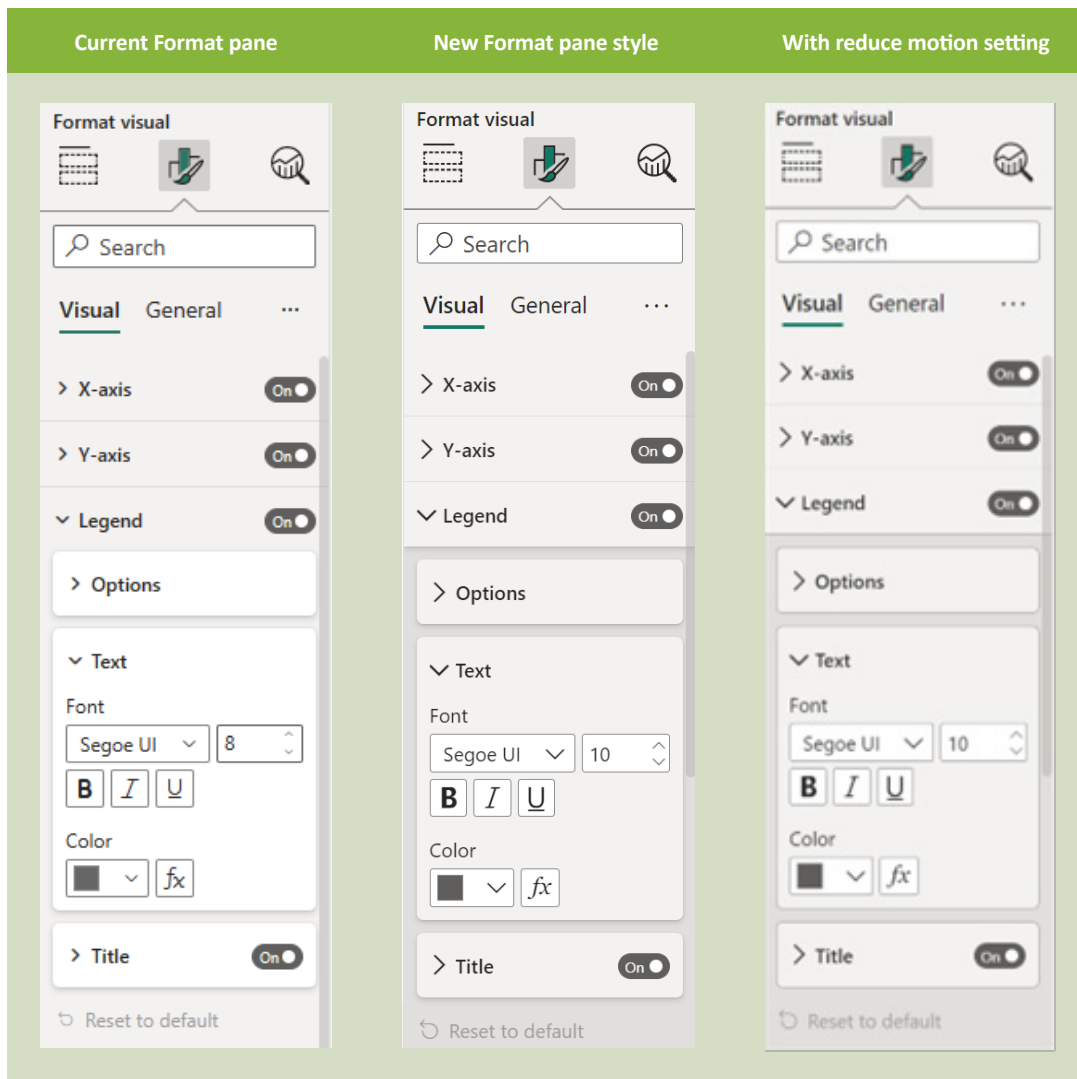
Cancel

The 'Clear all slicers' button has also been added: when there are several slicers on a report page and you want a way to quickly clear all their selections, add the 'Clear all slicers' button and users may do so in one click.

Finally, the 'Optimize' Ribbon with Pause visuals, Optimization presets and the quick access to 'Apply all slicers' button is on by default as a Preview feature starting with this release.

New styling for the Format Pane

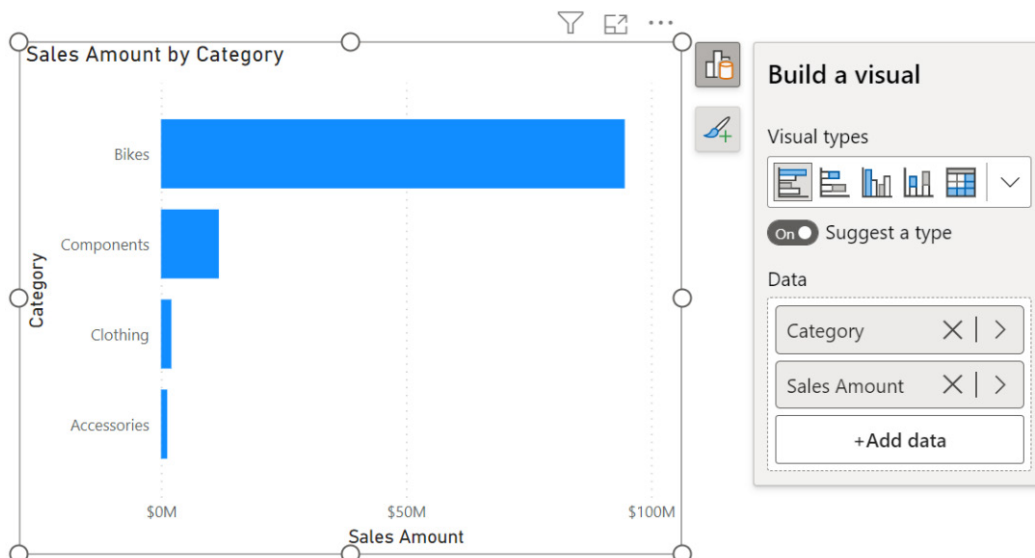
Microsoft has noted and addressed customer feedback on the depth perceived by the white background and drop shadow treatment, which has apparently caused dizziness from the new Format pane. Therefore, this update darkens the style and adds borders instead of drop shadows when the operating system (OS) setting for reduced motion is enabled.

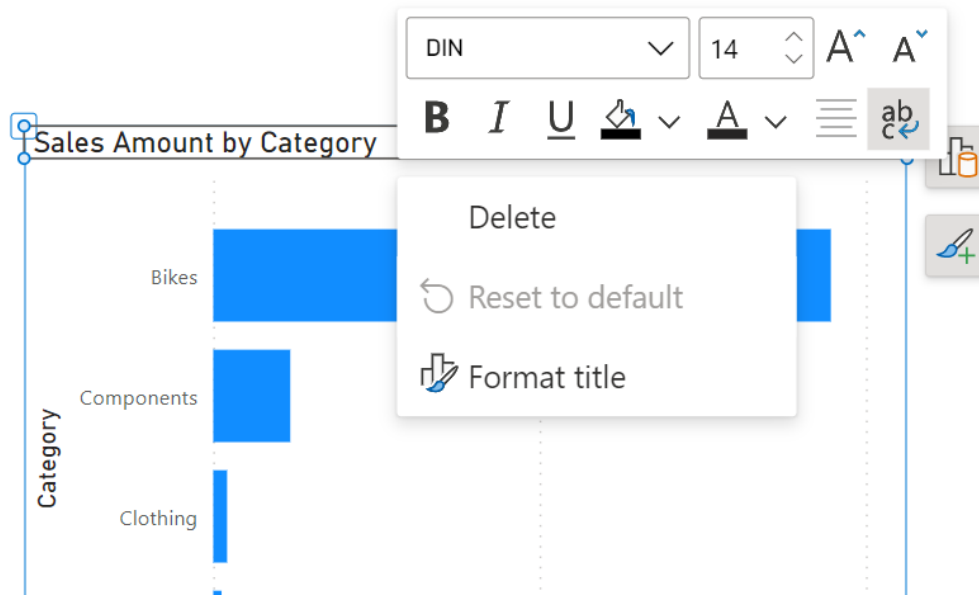


On-object interaction (opt-in) in Preview

On-object is a new way to build and format visuals. Microsoft has commissioned various research studies which have advised that many feel Power BI Desktop is hard to use. If I am to opine personally, I would probably say the constant moving of things does cause user consternation and exasperation. Indeed, Microsoft has stated that its staff have witnessed countless new users struggle to navigate the user interface (UI) to perform simple actions such as completely missing the

Fields pane, being unable to add data to the correct field wells, hunting around the Format pane to rename, change colours or format text styles for their visual. These same users instinctively right-click on areas of the visual expecting a menu to help. Aligning to Power BI's new "Office-like" strategy, this update introduces On-object, a new way to build and format visuals directly on the visual.





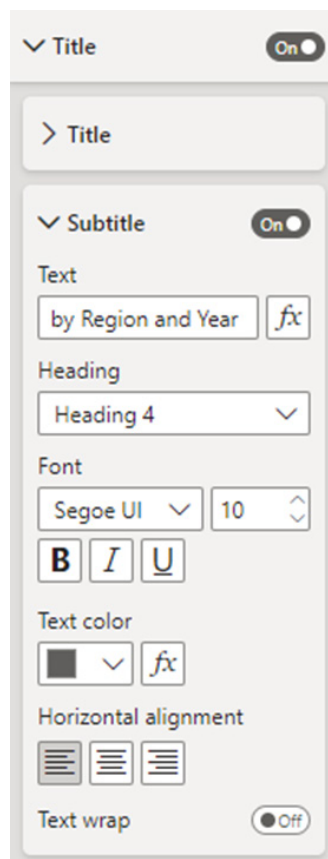
Try it out for yourself. Simply switch on the Preview: **File -> Options and settings -> Options -> Preview Features -> On-object interaction.**

Visual container improvements

With this release, Power BI has introduced four key features to help you customise your visuals' containers.

SUBTITLE

You can now turn on a subtitle that can be used to add extra context to your visuals. You'll find the new 'Subtitle' toggle in the 'Title' settings card of the Formatting pane.

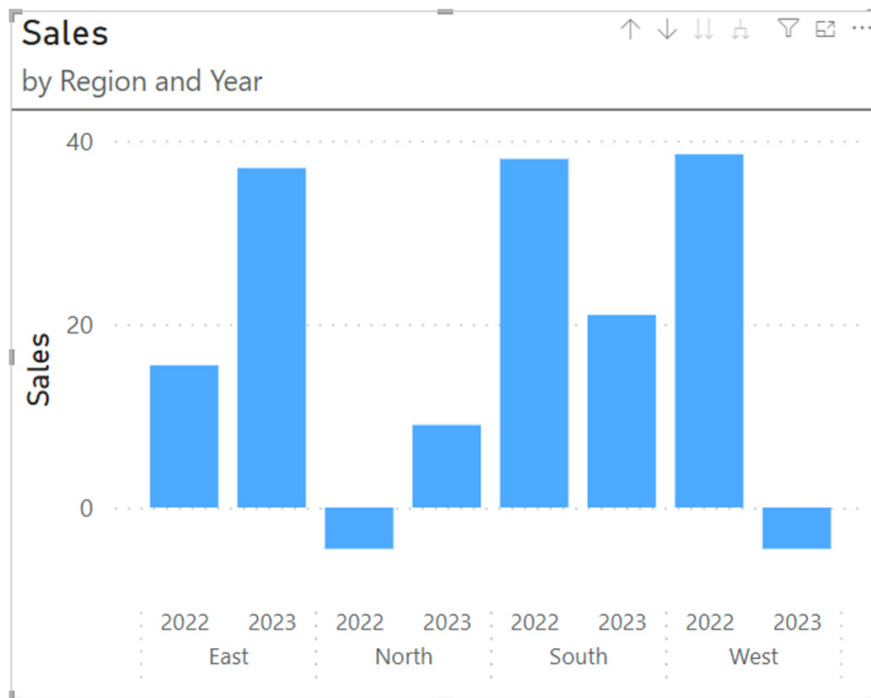


DIVIDER

To visually separate the visual header from its contents you can add a divider line. You can find the 'Divider' option in the 'Title' settings card of the Formatting pane, below the new 'Subtitle'.

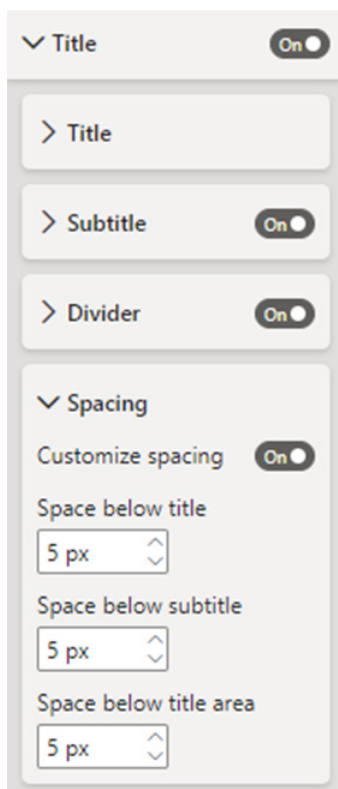


Here's an example visual container with Subtitle and Divider both switched on:



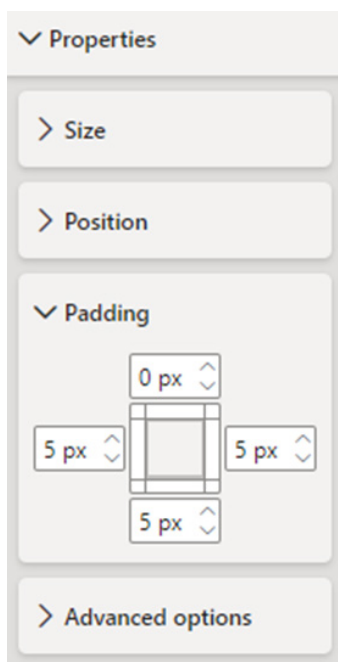
SPACING

In addition to the Subtitle and Divider on your visual container, you can control the space below each component too. You'll find the 'Spacing' setting at the bottom of the 'Title' settings card of the Formatting pane.



PADDING

You can now control the container's margin to create a negative space making the visuals look more professional and appealing. You'll find this new option in the Properties card of the Formatting pane.



Google BigQuery and Google BigQuery Azure AD (connector update)

This update contains bug fixes on the Azure Active Directory Single-Sign On scenario.

Azure Databricks and Databricks (connector update)

The Azure Databricks and Databricks connectors have been updated. This latest release contains the following fixes and improvements:

- fixed DAX **DAY**, **MONTH** and **YEAR** queries. Now, the DAX **DAY** query works and **MONTH** and **YEAR** DAX queries generate more efficient queries pushed down to the Databricks SqlWarehouse
- improved Native Query by caching the result of schema inference query instead of issuing multiple schema inference queries
- improved Native Query performance by utilizing LIMIT 0 query for schema inference (clear as mud!).

Dremio Cloud (connector update)

The Dremio Cloud connector has been updated and has now removed the Beta flag. Further, it is now Generally Available.

FactSet RMS (connector update)

The FactSet RMS connector has been updated to include support for Contact data stored in IRN, as well as improvements to Notes and Custom Symbol retrieval.

SurveyMonkey (connector update)

The SurveyMonkey connector has been updated to Version 1.2. Modifications include:

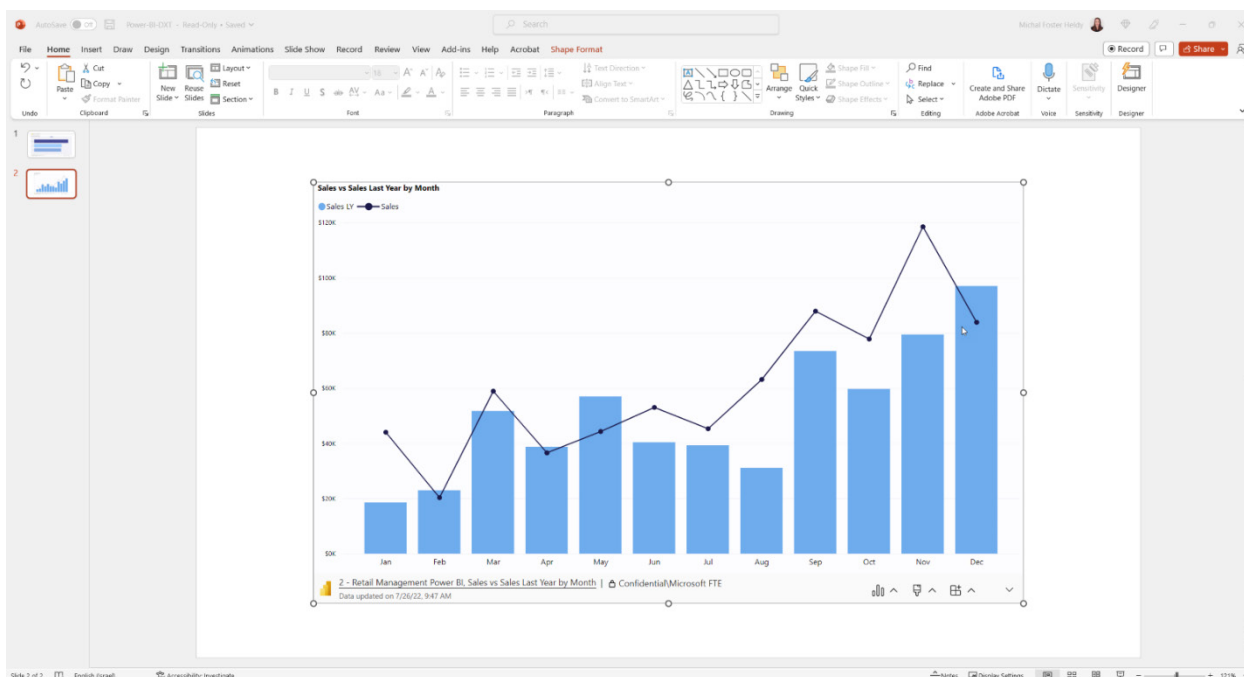
- Major performance enhancements
- Minor bug fixes
- Support for the following SuveryMonkey features:
 - Custom Variable exporting
 - Sentiment analysis
 - Tags.

Storytelling in PowerPoint now Generally Available

This update also sees the General Availability of Power BI's integration with PowerPoint that enables users to include interactive Power BI visuals in their PowerPoint presentations.

With the now-General Availability of the Power BI add-in for PowerPoint:

- the Power BI / PowerPoint integration will be enabled in all Microsoft clouds
- users will be able to add single visuals to PowerPoint slides, not just complete report pages
- recipients may use smart insights to get a text narrative of the data displayed in the add-in.



Power BI org app Multiple Audiences now Generally Available

Since the announcement in August last year regarding launching the Public Preview of Multiple Audiences for Power BI org apps, this feature has now been made Generally Available. With this, the multiple audience feature will now be supported by Power BI Mobile. As stated, with

multiple audiences for an app, Power BI App author can create multiple audience groups within the same application and assign different permissions to each group.

Announcing new Scanner API scenarios

The Scanner API is part of the Power BI admin API. It enables administrators to efficiently and automatically retrieve valuable information about their organisation's Power BI assets, such as inventory, metadata and lineage. In turn, they can leverage this information for their own custom-made solutions.

The API was developed with the aim of improving the efficiency and performance of the Power BI scan so that it could support large numbers of data assets while still conforming to the security practices

of organisations. The scanner supports service principle authentication and incremental scanning, and returns metadata such as endorsement status, sensitivity label, etc.

The Scanner API attained General Availability over a year ago, and a growing number of entities now actively use it to better understand their products and to get information that helps them achieve their governance goals.

This also now supports:

- **additional artifact metadata:** scheduled refresh settings and RDL data source properties
- **dataset sub-artifact metadata:** dataset tables whose 'Enable load' property is set to OFF, RLS configuration
- **dataset sub-artifact coverage:** XMLA changes, Autogenerated datasets, Datasets created via 'Quick create' and 'Quick share', Web modelling modifications
- **datamarts support.**

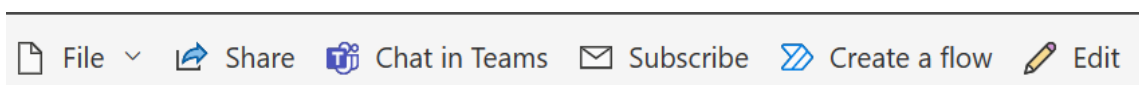
The image below is an example for scheduled refresh settings for Power BI models (dataset, dataflow, datamart):

```
    "datasets": [
      {
        "id": "0aacd0ec-36dd-446a-8f6b-eb3f73691762",
        "name": "SampleDataset",
        "tables": [],
        "configuredBy": "alias@microsoft.com",
        "configuredById": "fedabcd4-0ab9-4e89-b7a5-a7e07125d601",
        "isEffectiveIdentityRequired": true,
        "isEffectiveIdentityRolesRequired": true,
        "refreshSchedule": {
          "days": [
            "Tuesday",
            "Wednesday"
          ],
          "times": [
            "01:00",
            "01:30",
            "02:00"
          ],
          "enabled": true,
          "localTimeZoneId": "AUS Eastern Standard Time",
          "notifyOption": "MailOnFailure"
        },
        "targetStorageMode": "Abf",
        "createdDate": "2021-12-05T08:49:23.99",
        "contentProviderType": "PbixInImportMode",
      }
    ]
  }
```

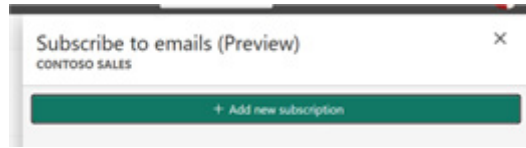
Email Subscriptions

This month also sees the release of email subscriptions for scorecards. Subscriptions enable you to receive email notifications and stay up to date on the scorecards that matter most to you and your team.

To set up a subscription, select the Subscribe button in the Ribbon:

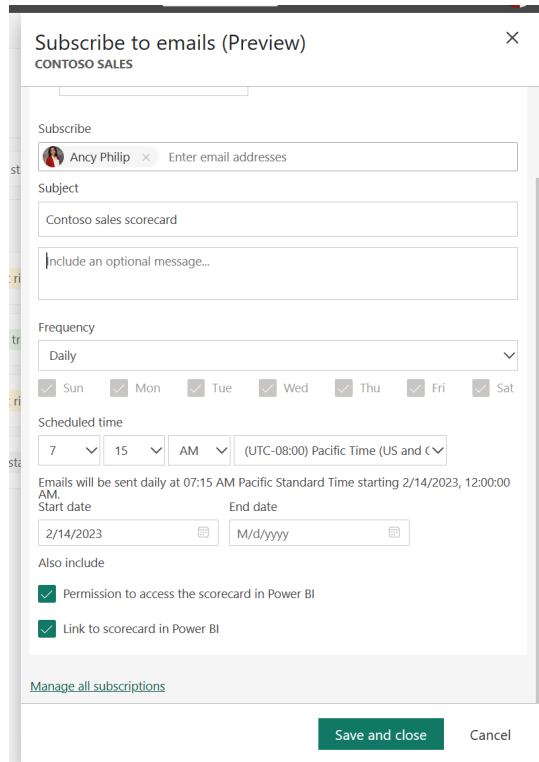


Then, select 'Add a new subscription' in the pane that opens on the right side:

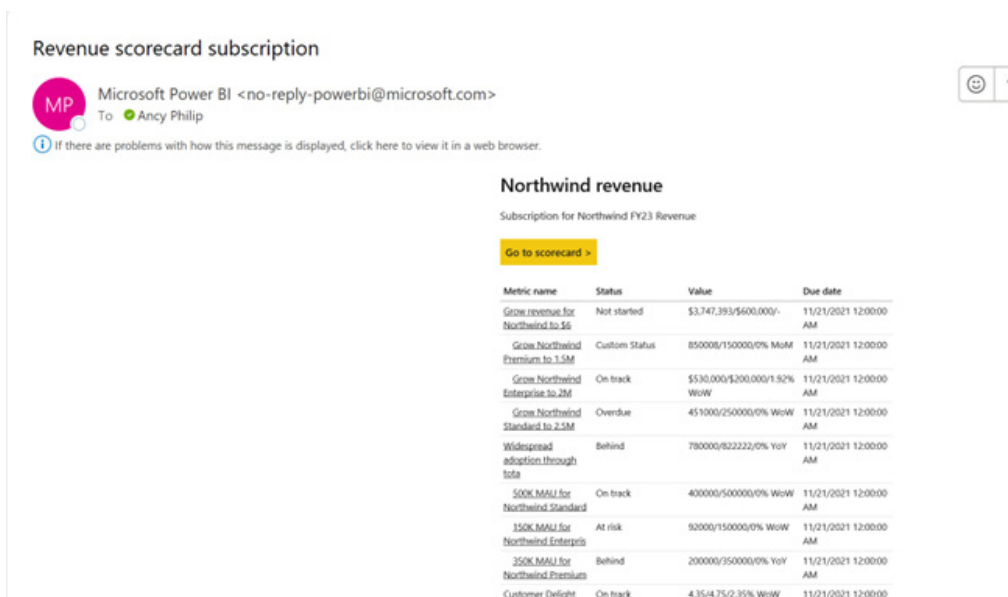


Enter the details about the subscription such as the name for the subscription, subject and email message details. Then, set the frequency on how often you want to receive the emails such as hourly, daily, weekly or monthly. Also, you may set a scheduled time for the subscription, such as on the hour, or at 15, 30 or 45 minutes past, AM or PM, and specify

the time zone. You may then select a 'Start date' and optionally an 'End date' for the subscription. You can also include a link to the scorecard in the email and give recipients permission to view the scorecard. Finally, select 'Save and close'. After saving, you can edit the subscription, turn it on and off or delete the subscription.



Recipients will receive an email from Power BI with a table containing the scorecard data such as metric name, status, values and due date. The table will show up to 50 metrics, viz.



You can add up to 24 subscriptions per scorecard, with unique recipients, times and frequencies for each subscription. You can see all the subscriptions by opening the Subscriptions pane from a scorecard in 'My workspace', and selecting 'Manage all subscriptions', or from under the **Settings -> Subscriptions** tab in the upper right corner of Power BI Service.

Note that you can subscribe to scorecards if you have a Pro license or PPU license or if scorecard is in a workspace backed by Premium capacity.

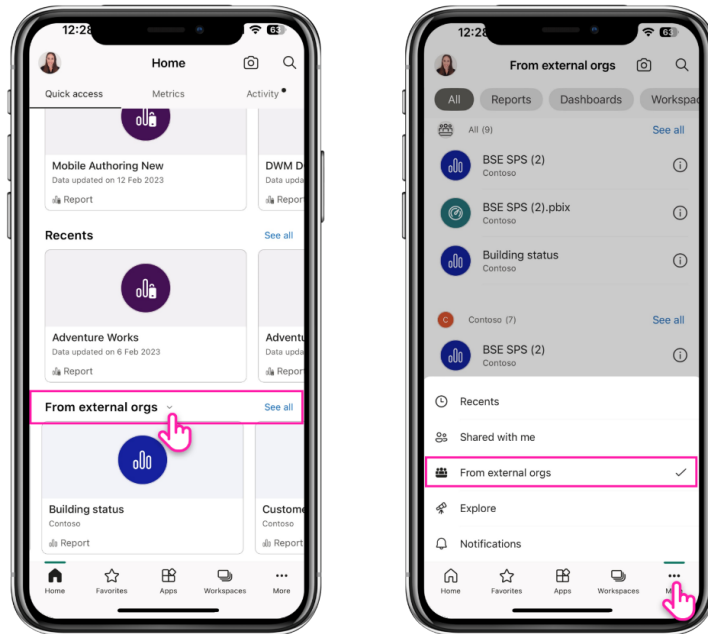
Discover external orgs content in your Mobile application

It has become easier to access your external content from your Power BI mobile app. You no longer need to have a link to access such items. If you have access to items from external organisations, you can now have these items always show up for quick access on the app's home page by default. Just tap the newly added drop down arrow on the third content strip to change 'Recommended' to 'From external orgs'.

You can subscribe other team members if in addition to the above, you are a Contributor, Member or Administrator in that workspace. If the scorecard isn't hosted in a Premium capacity, others must also have a Pro license. You can add other email addresses in the same domain to the subscription. If the scorecard is hosted in a Premium capacity, you can subscribe group aliases, whether they're in your domain or not. You may subscribe external users if scorecard is hosted in a Premium capacity too.

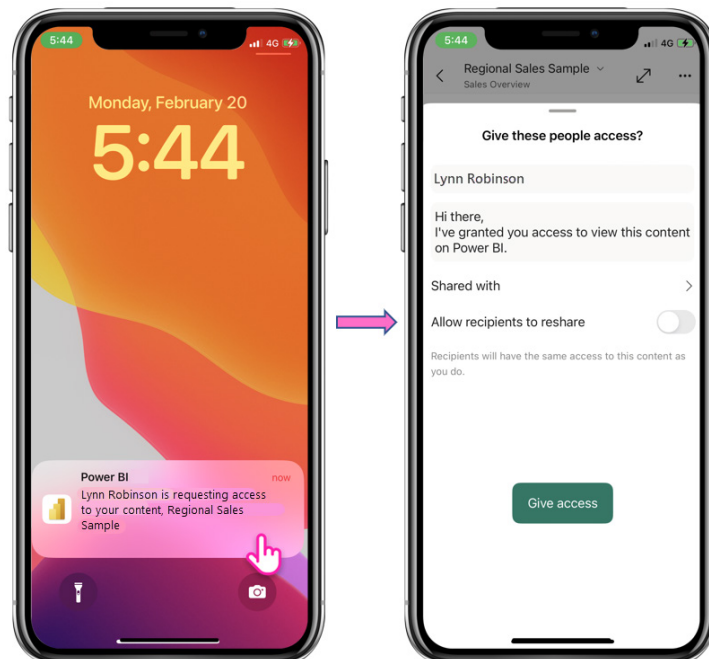
You can also access your external items by tapping 'More options...' and selecting 'From external orgs'.

Tapping an item takes you to the external tenant, where as a guest user you'll be able to view all the content that's been shared with you there.



Grant access on the go

You now get a push notification on your mobile app whenever someone requests access to one of your reports. Simply tap the notification to respond immediately.



New visuals in AppSource

There are two for this month:

- Horizontal Bullet Chart with Label
- Banzai BI Dashboard.

Financial Reporting Matrix v7.0

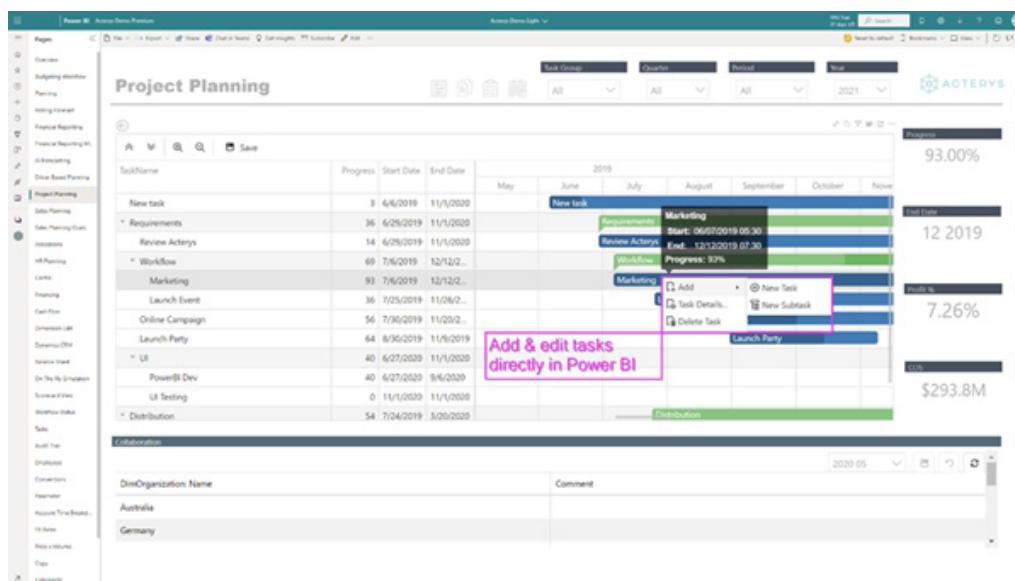
Version 7.0 of the Financial Reporting Matrix is now out. The 'Export to Excel' feature grants users the ability to export their matrix, preserving its aesthetic and professional quality. With a few clicks, the matrix can be exported to Excel.

Acterys Variance

This provides KPI cards with planning and forecasting options. You may switch between different display options: absolute, relative and waterfall in a vertical or horizontal small multiple display. Further, you may also set cut off period and see projected results if your plan changes in real-time.

Features include:

- analyse actual / target variances with support for small multiples and four [4] visualisation types (combined, absolute / relative variance and waterfall) and zoom in option
- advanced forecasting and planning on any level by dragging on the bars. Set cut off periods see projections based upon plan changes in real-time
- fully configurable KPI indicator display
- option to display total across all cards
- zoom into charts
- category drill down
- write back, planning and forecasting (requires Acterys subscription)
- supports all Power BI features, such as custom ToolTips and drill through.

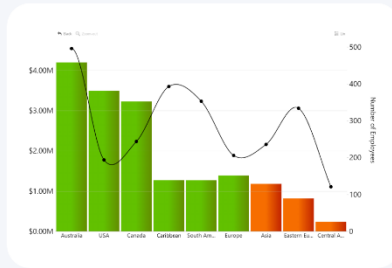


Feature Summary for Drill Down Combo PRO

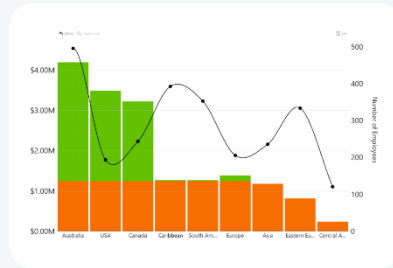
Drill Down Combo PRO allows report creators to build charts of categorical data. You can choose from multiple chart types and create Column, Line, Area and their Combination charts. There are also customisation options to make your chart unique whilst enhancing the readability of your data with features like conditional formatting and dynamic thresholds.



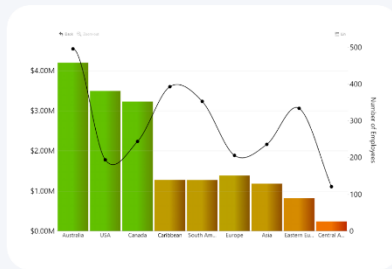
Color Mode - Solid H Color



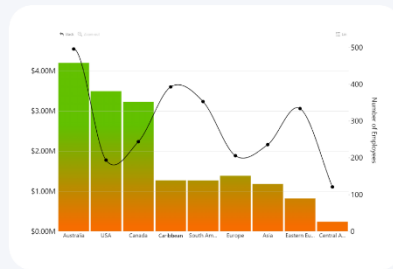
Color Mode - Solid V Color



Color Mode - Stepped Color



Color Mode - Gradient



zoomcharts.com/powerbi

Main features include:

- **conditional formatting:** compare results against forecasts by automatically adjusting formatting based upon a numerical value
- **full customisation:** customise X and Y axes, the legend, outline and fill settings
- **choose normal, 100% proportional or zero-based stacking**
- **set up to four [4] static and / or dynamic thresholds** to demonstrate targets
- **customise multiple series simultaneously** with series and value label defaults.

Popular use cases include:

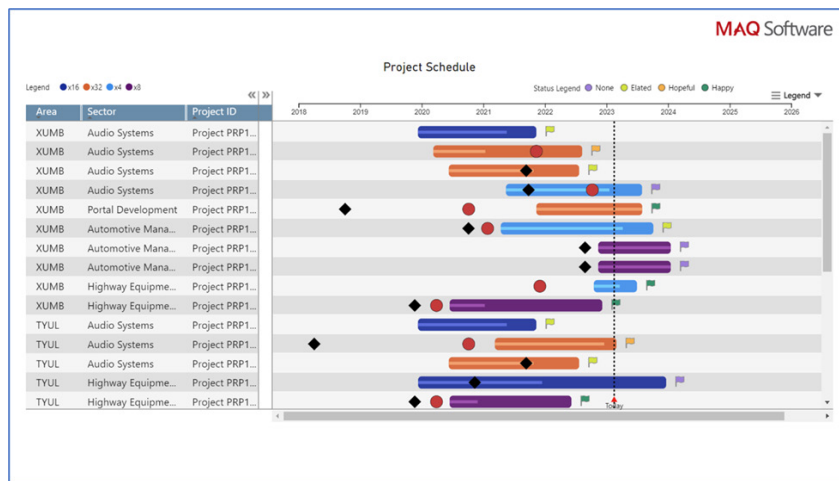
- **sales and marketing:** sales strategies, results, marketing metrics
- **human resources:** hiring, overtime and efficiency ratios by department
- **accounting and finance:** financial performance by region, office or business line
- **manufacturing:** production and quality metrics.

ZoomCharts Drill Down Visuals are known for interactive drilldowns, cross-filtering and numerous customisation options. They support interactions, selections, custom and native ToolTips, filtering, bookmarks and context menus.

Gantt Chart by MAQ Software (Premium)

A premium version of the visual with the following advanced features has now been released. Features include:

- **progress bar:** accepts % and measure values between zero [0] and one [1]
- **task status:** accepts categorical values for mapping status flags for each task
- **milestones:** accepts up to five [5] date fields for showing milestone shapes as per user settings
- **configurable bar height:** user setting to change the height of task rows
- **category limit increased to 10** (from four [4]).



That's it for this month: more anon.

New Features for Excel

This month's updates include the ability to manually sort row and column values in PivotTables to users of Excel for the web. For Insiders, users can also check out automatic recalculation optimisation – but that's not all.

The full list is as follows:

Excel for the web

- PivotTables: manual sort (drag) of rows and column values

Excel for Windows

- Automatic recalculation optimisation (Insiders)
- Block untrusted XLL add-ins (Insiders)

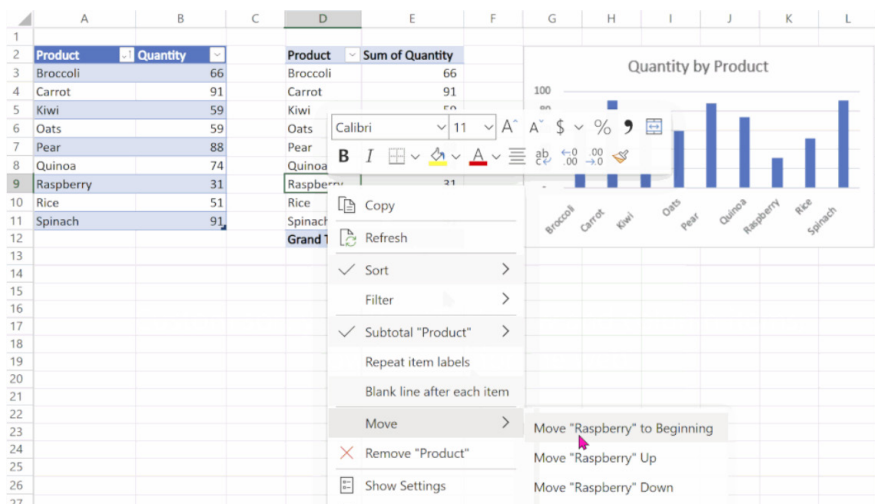
Excel for Mac

- Power Query Editor:
 - Import data from additional sources
 - Import data from SQL Server databases (Insiders)
- Automatic recalculation optimisation (Insiders).

Let's plough through.

PivotTables: manual sort (drag) of rows and column values

Excel for the web now allows manual sorting for PivotTables and PivotCharts. Now you may customise the sort order of your PivotTable row and column items beyond the standard ascending and descending options. This feature, previously only available in the Excel desktop application, allows you to manually sort specific row or column items by dragging them or using the context (right-click) menu.



Automatic recalculation optimisation (Insiders)

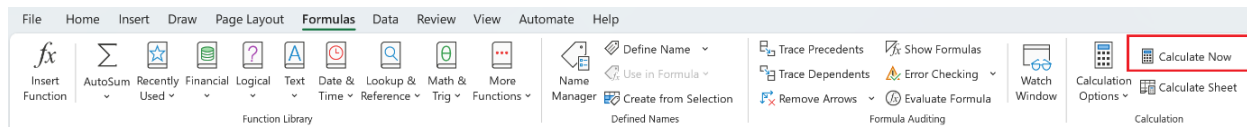
For Excel for Windows and Excel for Mac, Microsoft is minimising the risk of slow performance by limiting the recalculation process to the active workbook and any of its interdependent workbooks only. This improvement reduces the chances of slowness or freezing in the active workbook (the one you are actively working in) when multiple workbooks are open.

The introduction of the single document interface (SDI) in Excel 2013 made it possible for users to open and run multiple, unrelated workbooks in a single instance of Excel. Additionally, when using the Automatic Calculation mode, any of these workbooks had the potential to trigger a

recalculation of all open workbooks, which increased the risk of slowing down the performance of the active workbook.

Therefore, Microsoft is minimising the risk of slowness and increasing performance by limiting the recalculation process to the active workbook and any of its interdependent workbooks.

It should be noted that workbooks with real-time streaming functionality (such as Realtime Data), as well as recalculation initiated either programmatically or manually by pressing the **F9** key or selecting **Formulas -> Calculate Now** are exceptions to this optimisation.



This feature is available to Insiders running:

- **Windows:** Version 2208 (Build 15529.10000) or later
- **Mac:** Version 16.64 (Build 22081401) or later.

Block untrusted XLL add-ins (Insiders)

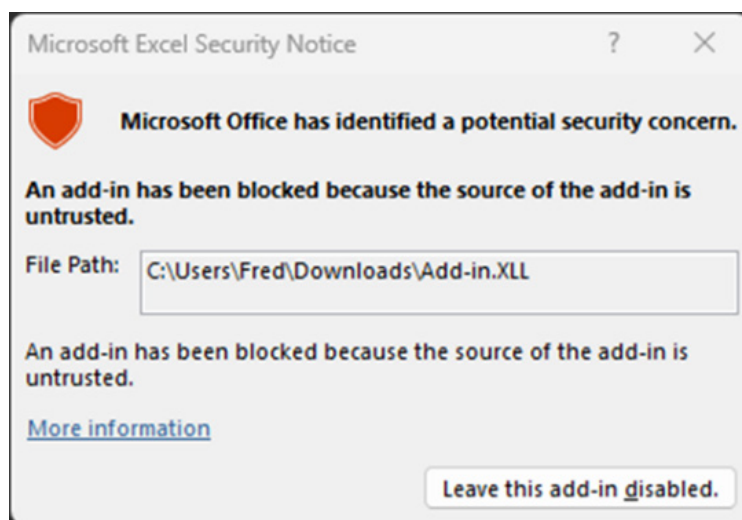
Add-ins can add a lot of functionality to Microsoft 365, but they can also be employed by bad actors to disseminate malware. Thus, Microsoft has taken steps to help protect users by blocking XLL add-ins. Whether this is overkill, we will have to wait and see.

With this update in Excel for Windows (Insiders), you will no longer be able to enable XLL add-ins in files obtained from the internet with the click of a button, which will either be a blessing or a curse. Instead, a

message will now appear, notifying you of the risk you are taking and offering a link to more information about possible workarounds.

It should be noted that this setting change only blocks XLL add-ins – not all add-ins. For example, add-ins from the Store will not be affected.

If you open an Excel file that contains an XLL add-in from an untrusted source, the following dialog will appear:

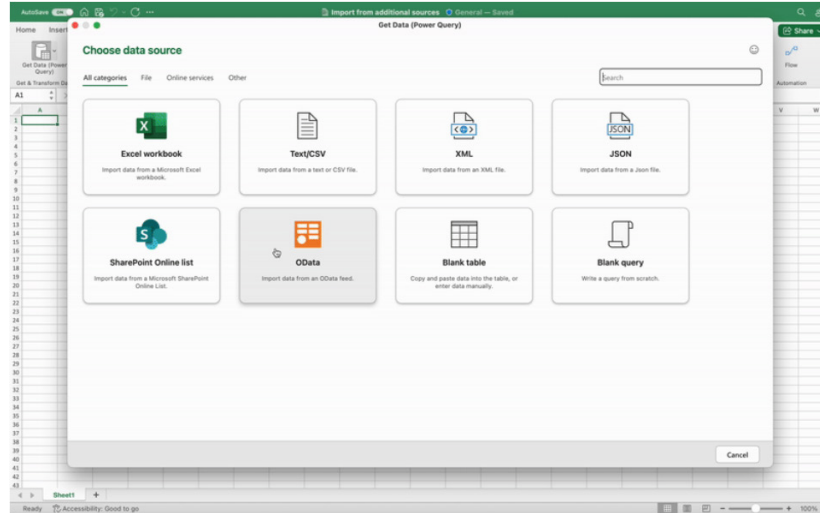


In the Microsoft Excel Security Notice message box, review the source of the add-in and click the 'Leave this add-in disabled' button, for example.

This feature is rolling out to Insiders on Excel for Windows who are running Version 2302 (Build 16130.20128) or later.

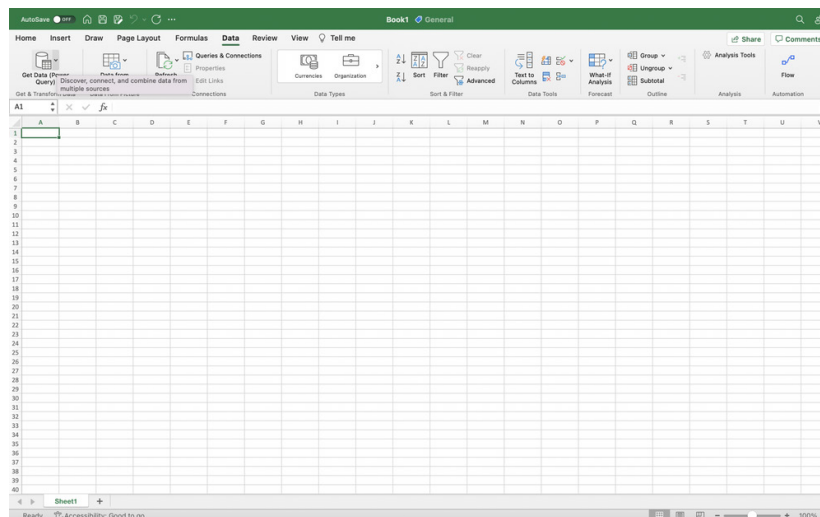
Power Query Editor

You can now author queries from local files, SharePoint, OData and various other sources with the Power Query Editor in Excel for Mac.

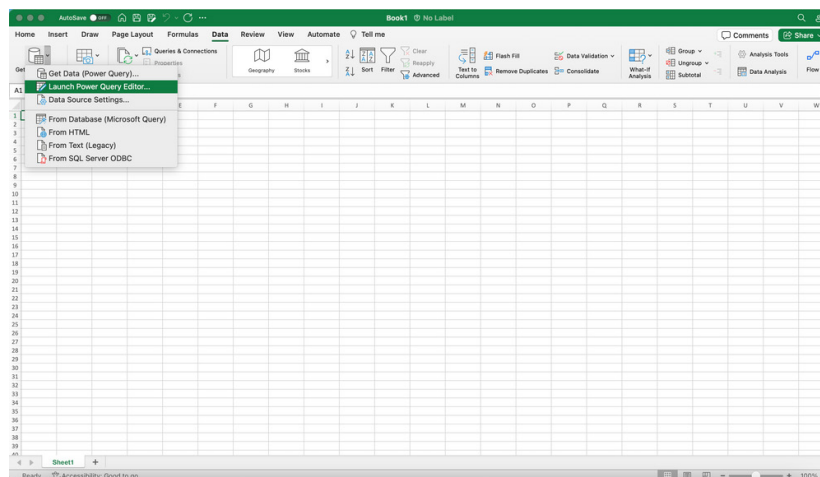


The ability to refresh data was introduced into Excel for Mac back in 2020, with the ability to import (some) data in 2021. But now, you can clean / shape the data with numerous transformations now available in Apple Land.

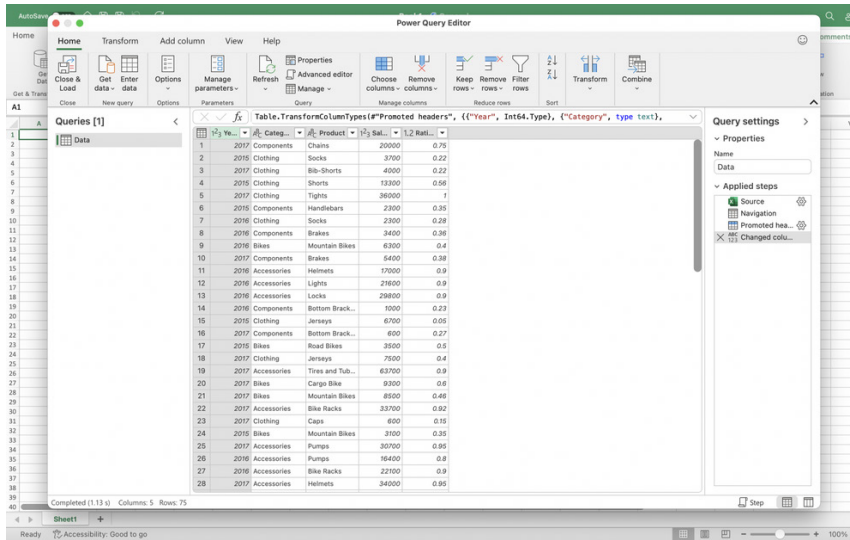
To access the new features, on the Data tab, click the 'Get Data (Power Query)' button:



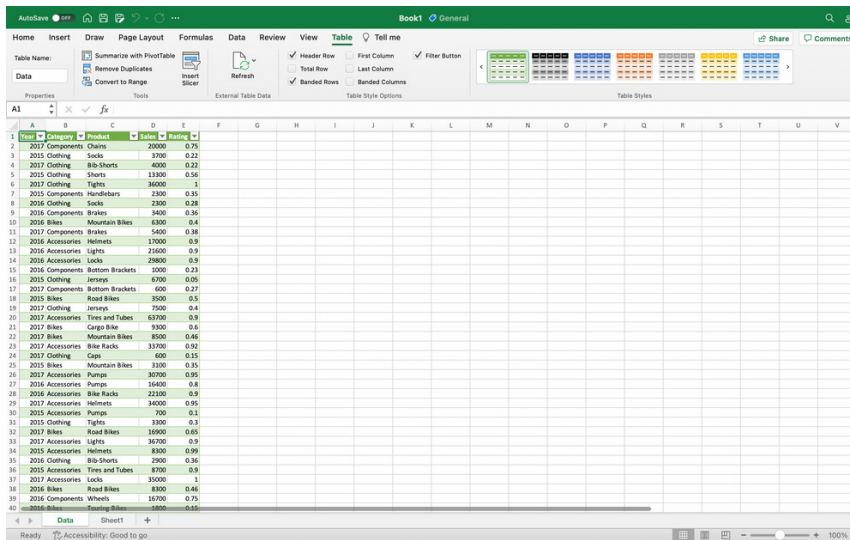
Then, click on 'Launch Power Query Editor' to open the Query Editor.



You can shape and transform your data using the Query Editor as you would in Excel for Windows. When you're done, simply click the 'Close & Load' button on the Home tab.

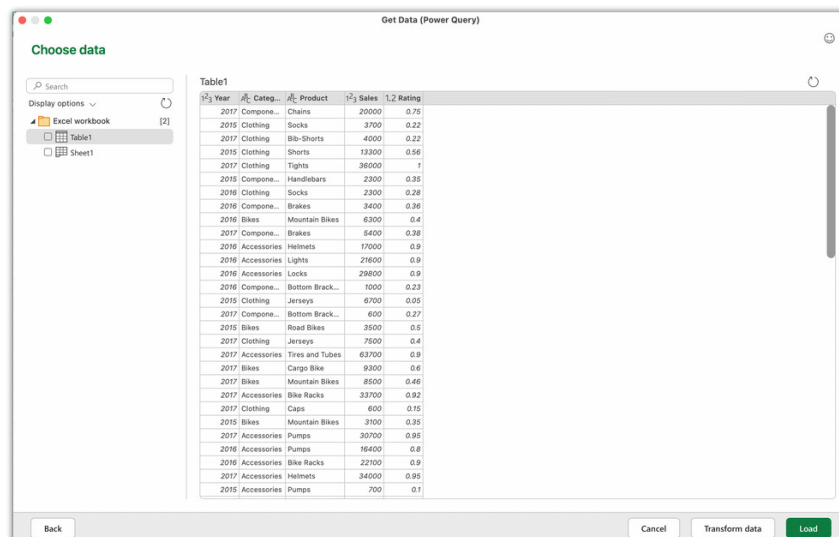


And that's it!



Supported data sources include Blank Query, Blank Table, CSV, JSON files, local tables and ranges, Microsoft SQL Server, OData, SharePoint, SharePoint Folders, SharePoint Lists, text, XLSX and XML.

You should note that you may also access the Query Editor from the data import flow by clicking the 'Get Data (Power Query)' button, choosing a data source, and clicking the 'Transform Data' button:



This feature is Generally Available in Excel for Microsoft 365 for Mac version 16.69 (23010700) or later.

The updated version of the grid with all the new features is fast becoming too complicated to show clearly here. Nonetheless, you can find the interactive links at aka.ms/ExcelFeaturesFlyer.

Excel Features Availability

Page 1 of 4

Feature	Insider		Production				Web
	Windows Find the latest Excel version for this platform	Mac Find the latest Excel version for this platform	Windows/CC Find the latest Excel version for this platform	Windows/MEC Find the latest Excel version for this platform	Windows/SA Find the latest Excel version for this platform	Mac Find the latest Excel version for this platform	
Block XLL Add-Ins	Version 2302 (Build 16136.20128) or later						
PivotTables: Manual Sort of Rows & Columns			Already Supported	Already Supported	Already Supported	Already Supported	February 2023
Automatic Recalculation Optimization	Version 2208 (Build 15529.10000) or later	Version 16.64 (Build 22081401) or later					
Import Data from SQL Server Database		Version 16.68 (Build 22110801) or later					
Import Data from Additional Sources						Version 16.69 (Build 23010700) or later	
Power Query Editor						Version 16.69 (Build 23010700) or later	
IMAGE Function			Version 2211 (Build 15831.20190) or later	Version 2211 (Build 15831.20252) or later		Version 16.67 (Build 22102900) or later	December 2022
Check Formula with Value Preview Tooltips	Version 2302 (Build 16116.20000) or later	Version 16.70 (Build 230116)					
Office Scripts	Version 2212 (Build 15922.20000) or later	Version 16.68 (Build 22120101) or later					
Automate Tasks with Power Automate tab			Version 2301 (Build 15703.10000) or later			Version 16.66 (Build 22092500) or later	
PivotTable Show Details to XLO							January 2023
Excel Live in Teams							December 2022
Formula Suggestions							December 2022*
Formula by Example							December 2022*
Suggested Links							December 2022
Add search bar in queries pane							December 2022

*Starting to roll out

Features Flyer: aka.ms/ExcelFeaturesFlyer

CC: Current Channel; MEC: Monthly Enterprise Channel; SA: Semi Annual Enterprise Channel. All information is subject to change.

Excel Features Availability

Page 2 of 4

Feature	Insider		Production				Web
	Windows Find the latest Excel version for this platform	Mac Find the latest Excel version for this platform	Windows/CC Find the latest Excel version for this platform	Windows/MEC Find the latest Excel version for this platform	Windows/SA Find the latest Excel version for this platform	Mac Find the latest Excel version for this platform	
Add keyboard shortcut to open PQ editor			Version 2211 (Build 15730.31883) or later				
Create nested PQ data types	Version 2211 (Build 15928.10000) or later						
Add Get Data from Dynamic Arrays	Version 2105 (Build 14014.20002) or later						
Data from picture			Version 2210 (Build 15723) or later	Version 2210 (Build 15726.20262) or later		Version 16.38 or later	December 2022
Chart Data Foils							November 2022
Show Changes			Version 2209 (Build 15703.10000) or later			Version 16.66 (Build 22092500) or later	Already Supported
New Paste Options	Version 2210 (Build 15726.20000) or later						
Quickly Find the Command you need			Version 2206 (Build 15311.20040) or later				October 2022
New DAX Functions	Version 2208 (Build 15504.10000) or later						
Navigation Pane			Version 2209 (Build 15629.10000) or later				
Smooth Scrolling			Version 2205 (Build 15225.20092) or later	Version 2208 (Build 15601.20230)	Version 2208 (Build 15601.20456) or later	Already Supported	Already Supported
Check Performance							September 2022
Share Section of Excel Workbook							September 2022
Dynamic Array Support in Charts	Version 2209 (Build 15617.10000) or later			Version 2210 (Build 15726.20262) or later			September 2022
Modern Comments			Version 2209 (Build 15427.20000) or later				
Manage Your Storage Accounts from Mac		Version 16.64 (Build 22082100) or later					

Features Flyer: aka.ms/ExcelFeaturesFlyer

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Excel Features Availability

Page 3 of 4

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	Windows Find the latest Excel version for this platform	Mac Find the latest Excel version for this platform	Windows/CC Find the latest Excel version for this platform	Windows/MEC Find the latest Excel version for this platform	Windows/SA Find the latest Excel version for this platform	Mac Find the latest Excel version for this platform	
New Excel functions			Version 2208 (Build 15427.20194) or later	Version 2208 (Build 15601.20230) or later		Version 16.64 (Build 22081401) or later	August 2022
Power Query Group operations							August 2022
Improvements to the connected Power BI experience	Version 2208 (Build 15601.20028) or later						August 2022
Add and edit rich text formatting			Already Supported	Already Supported	Already Supported	Already Supported	August 2022
Sort by color or icon from auto filter menu			Already Supported	Already Supported	Already Supported	Already Supported	August 2022
Edit files with legacy data connections			Already Supported	Already Supported	Already Supported	Already Supported	August 2022
Edit files with legacy Shared Workbook feature			Already Supported	Already Supported	Already Supported	Already Supported	August 2022
Delete chart elements							August 2022
Multiline formula bar							August 2022
Search within PivotTable Field List			Already Supported	Already Supported	Already Supported	Already Supported	July 2022
Set automatic data connections	Version 2207 (Build 15427.20000) or later						
Natural Language Query Improvements			Version 2206 (Build 15330.20230) or later	Version 2205 (Build 15225.20094) or later		Version 16.63 (Build 22070600) or later	
Basic Conditional Formatting dialog box		Version 16.64 (Build 22070600) or later					
Sheet protection			Already Supported	Already Supported	Already Supported	Already Supported	June 2022

Features Flyer: aka.ms/ExcelFeaturesFlyer

CC: Current Channel; MEC: Monthly Enterprise Channel; SA: Semi Annual Enterprise Channel. All information is subject to change.

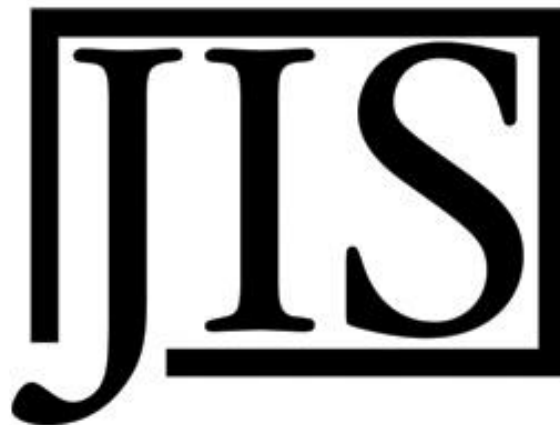
Feature	Insider		Production				Web
	Windows Find the latest Excel version for this platform	Mac Find the latest Excel version for this platform	Windows/CC Find the latest Excel version for this platform	Windows/MEC Find the latest Excel version for this platform	Windows/SA Find the latest Excel version for this platform	Mac Find the latest Excel version for this platform	
Semi-select for links creation			Already Supported	Already Supported	Already Supported	Already Supported	June 2022
Add "PivotTable Connections to Slicer settings pane"			Already Supported	Already Supported	Already Supported	Already Supported	June 2022
Import from local text, CSV, and XLSX files						Version 16.57 (2201100) or later	
Provide automatic alt-text suggestions on charts and PivotCharts			Version 2105 (Build 15225.20288) or later	Version 2204 (Build 15128.20280) or later		Version 16.62 (22061100) or later	
Power Query refresh for selected data sources			Already Supported	Already Supported	Already Supported	Already Supported	May 2022
Changing source file for workbook links			Already Supported	Already Supported	Already Supported	Already Supported	May 2022
Improved Recommended PivotTable experience	Version 2204 (Build 15128.10000) or later						
Faster recalc on resource constrained devices		Version 16.62 (Build 22050804) or later	Version 2204 (Build 15128.20248) or later	Version 2204 (Build 15128.20280) or later			
Faster Autofilter				Version 2204 (Build 15128.20248) or later	Version 2208 (Build 15601.20456) or later	Version 16.61 (22050700) or later	
Dataflow connector				Version 2203 (Build 15028.20248) or later			
Dataverse connector			Version 2204 (Build 15128.20178) or later				
Improved Find dialog and Find All						Version 16.60 (220410) or later	
LAMBDA Helper Functions			Version 2202 (Build 14931.20120) or later	Version 2202 (Build 14931.20278) or later	Version 2208 (Build 15601.20456) or later	Version 16.56 (Build 211211) or later	Already Supported

Features Flyer: aka.ms/ExcelFeaturesFlyer

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More next month, we're sure.

The A to Z of Excel Functions: JIS



There's a great trivia question out there that asks, which is the only letter of the alphabet for which there is no Excel function? Wiser hands than mine say this is "J". We say, "it depends". If they have Excel 2013 or later, "they" would be right as the JIS function was "retired" in this edition.

The JIS function (such an unfortunate name...) was renamed in Excel 2013 as DCBS (pretty obvious if you think about it – not). This function returns the text string converted from single byte (SCBS) to double byte (DCBS) characters.

A double-byte character set (DBCS) is a character encoding in which either all characters (including control characters) are encoded in two bytes,

or merely every graphic character not representable by an accompanying single-byte character set (SBCS) is encoded in two bytes (Han characters would generally comprise most of these two-byte characters). A DBCS supports national languages that contain many unique characters or symbols (the maximum number of characters that can be represented with one byte is 256 characters, while two bytes can represent up to 65,536 characters, i.e. 256²).

Examples of such languages include Japanese and Chinese. Korean Hangul does not contain as many characters, but KS X 1001 supports both Hangul and Hanja, and uses two bytes per character.

These are single-byte (half-width) characters.

アイエオカキクケコサシセソ

These are double-byte characters.

アイウエオカキクケコサシセソ

あいうえおかきくけこさしすせそ

一 二 三 四 五 六 七 八 区 十

This function converts half-width (single-byte) letters within a character string to full-width (double-byte) characters. The name of the function (and the characters that it converts) depends upon your language settings.

For Japanese, this function changes half-width (single-byte) English letters or katakana within a character string to full-width (double-byte) characters.

The **JIS** function employed the following syntax to operate:

JIS(text)

The **JIS** function had the following argument:

- **text**: this is required and represents the text you wish to convert from single byte to double byte characters.

It should be noted that:

- this function was removed in Excel 2013
- **DCBS** was introduced in Excel 2013 and has replaced this function
- this function does not appear in the Function Wizard
- if **text** does not contain any half-width characters, then **text** is not altered
- this function is used in connection to phonetics and using different types of fonts and languages
- you may use the **ASC** function to convert from double byte characters to single byte characters.

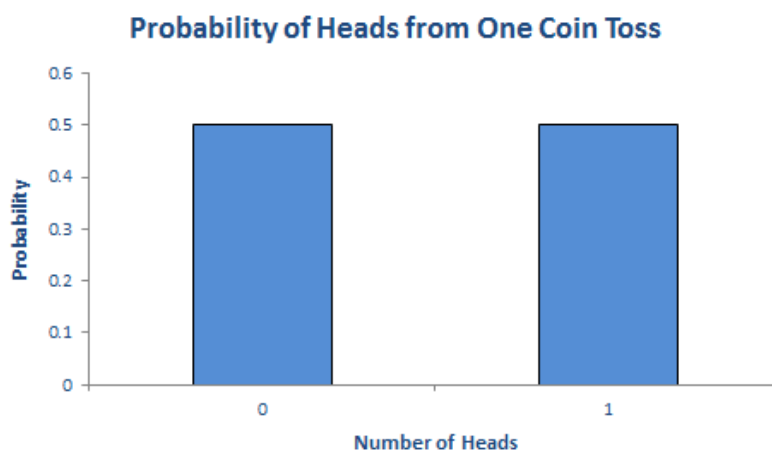
My example is extremely enlightening:

	A	B	C
1	Formula	Description	Result
2	<code>=JIS("some text")</code>	Returns the text string converted from single byte to double byte characters.	some text

The A to Z of Excel Functions: KURT

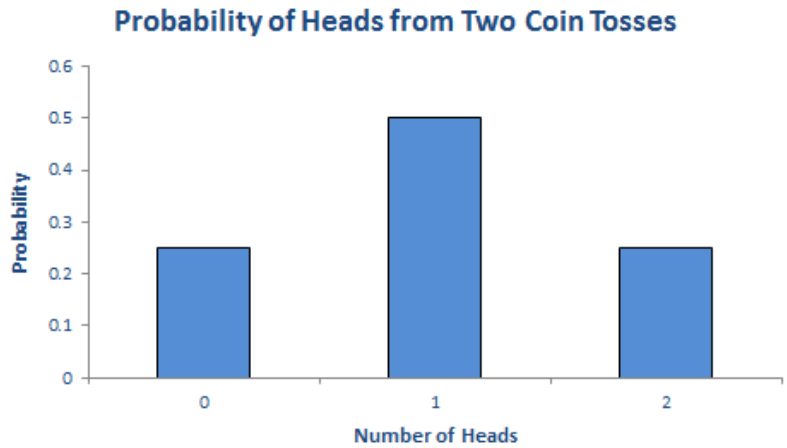


Imagine you toss an unbiased coin; half of the time it will come down heads, half tails:



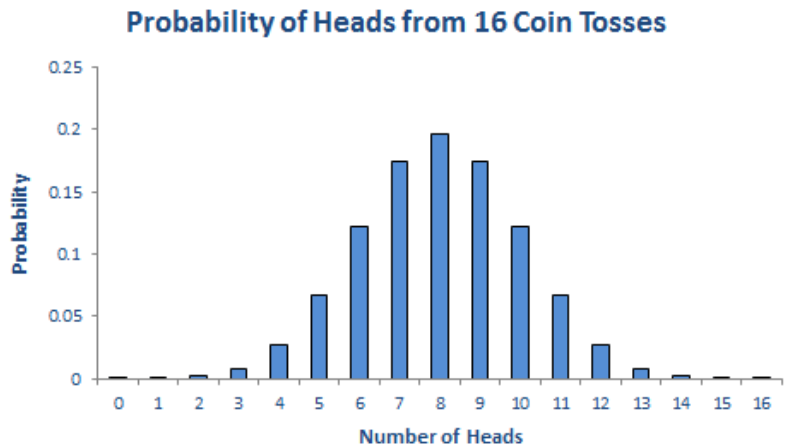
It is not the most exciting chart we have ever constructed, but it's a start.

If you toss two coins, there will be four possibilities: two Heads, a Head and a Tail, a Tail and a Head, and two Tails.



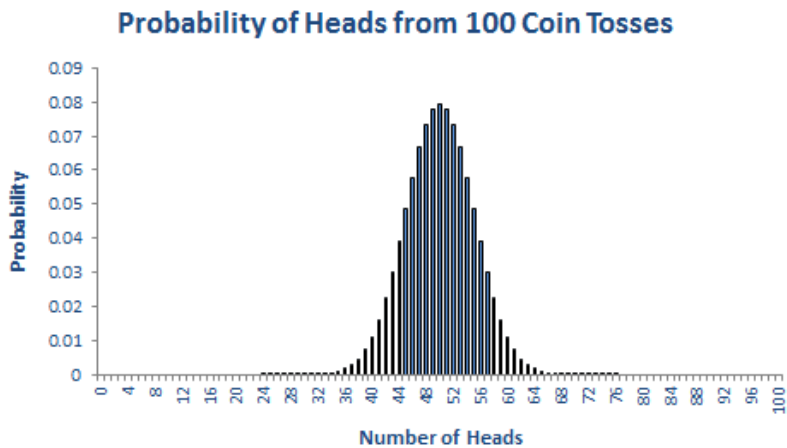
In summary, we should get two heads a quarter of the time, one head half of the time and no heads a quarter of the time. Note that $(1/4) + (1/2) + (1/4) = 1$. These fractions are the probabilities of the events occurring and the sum of all possible outcomes must always add up to 1.

The story is similar if we consider 16 coin tosses say:



Again, if you were to add up all of the individual probabilities, they would total to 1. Notice that in symmetrical distributions (such as this one) it is common for the most likely event (here, eight heads) to be the event at the midpoint.

Of course, why should we stop at 16 coin tosses?



All of these charts represent **probability distributions**, *i.e.* it displays how the probabilities of certain events occurring are distributed. If we can formulate a probability distribution, we can estimate the likelihood of a particular event occurring (*e.g.* probability of precisely 47 heads from 100 coin tosses is 0.0666, probability of less than or equal to 25 heads occurring in 100 coin tosses is 2.82×10^{-7}).

Now, assuming you can toss 100 coins, count the number of heads and record the outcome at one coin toss per second, it shouldn't take you more than 4.0×10^{22} **centuries** to generate every permutation. Even if we were to simulate this experiment using a computer programme capable of generating many calculations a second it would not be possible. For

example, in July 2022, a new computer (Frontier) was announced that could compute 1,000,000,000,000,000 calculations per second. If we could use this computer, it would only take us a mere 4,020 years to perform this computation. Sorry, but I can't afford the electricity bill. Imagine the price per kwh by then!

Let's put this all into perspective. All I am talking about here is considering 100 coin tosses. If only business were that *simple*. Potential outcomes for a business would be much more complex. Clearly, if we want to consider all possible outcomes, we can only do this using some sampling technique based on understanding the underlying probability distributions.

Probability Distributions

If I plotted charts for 1,000 or 10,000 coin tosses similar to the above, I would generate similarly shaped distributions. This classic distribution which only allows for two outcomes is known as the **Binomial distribution** and is regularly used in probabilistic analysis.

The 100 coin toss chart shows that the average (or '**expected**' or '**mean**') number of heads here is 50. This can be calculated using a weighted

average in the usual way. The 'spread' of heads is clearly quite narrow (tapering off very sharply at less than 40 heads or greater than 60). This spread is measured by statisticians using a measure called **standard deviation** which is defined as the square root of the average value of the square of the difference between each possible outcome and the mean, *i.e.*

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}$$

where: σ = standard deviation

N = total number of possible outcomes

Σ = summation

x_i = each outcome event (from first x_1 to last x_N)

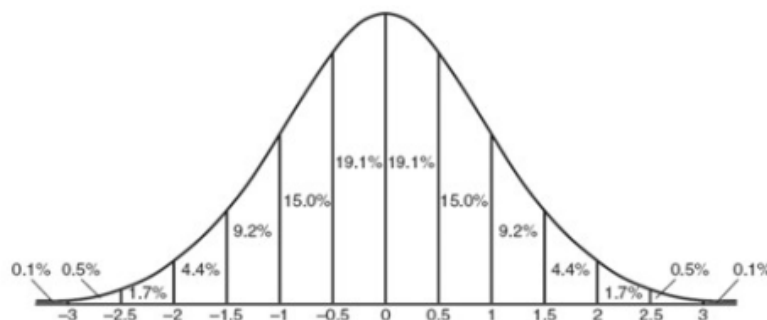
μ = mean or average

The Binomial distribution is not the most common distribution used in probability analysis: that honour belongs to the **Gaussian** or **Normal distribution**:



The Central Limit Theorem states that the sampling distribution of the sample means approaches a normal distribution as the sample size gets larger — no matter what the shape of the population distribution. This is why this distribution is so important in probability and statistics.

Generated by a complex mathematical formula, this distribution is defined by specifying the **mean** and **standard deviation** (see above). The Normal distribution's population is spread as follow:



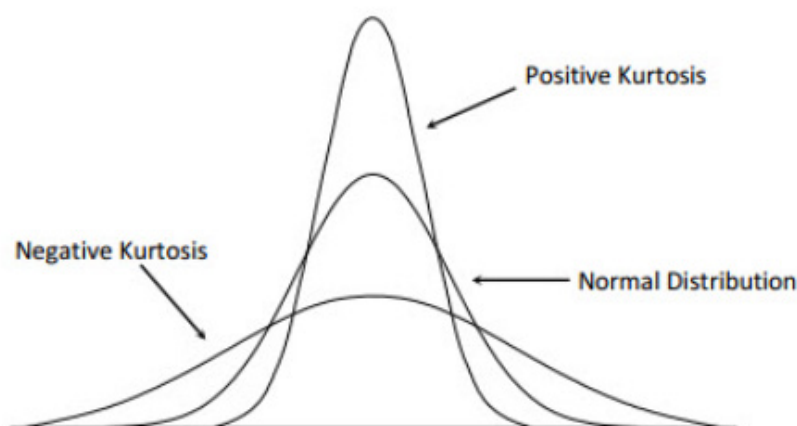
i.e. 68% of the population is within one standard deviation of the mean, 95% within two standard deviations and 99.7% within three standard deviations.

The formula for the Normal distribution is given by

$$p(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$$

and is regularly used for comparison purposes.

The **KURT** function returns the kurtosis of a data set. Kurtosis characterises the relative peakedness or flatness of a distribution compared with the Normal distribution. Positive kurtosis indicates a relatively peaked distribution. Negative kurtosis indicates a relatively flat distribution.



The **KURT** function employs the following syntax to operate:

$$\mathbf{KURT}(\mathbf{number1}, [\mathbf{number2}], \dots)$$

The **KURT** function has the following arguments:

- **number1, number2, ...:** the first argument (**number1**) is required, whilst the subsequent arguments are optional. You may have between one (1) and 255 arguments to calculate kurtosis. You can also use a single array or a reference to an array instead of arguments separated by commas.

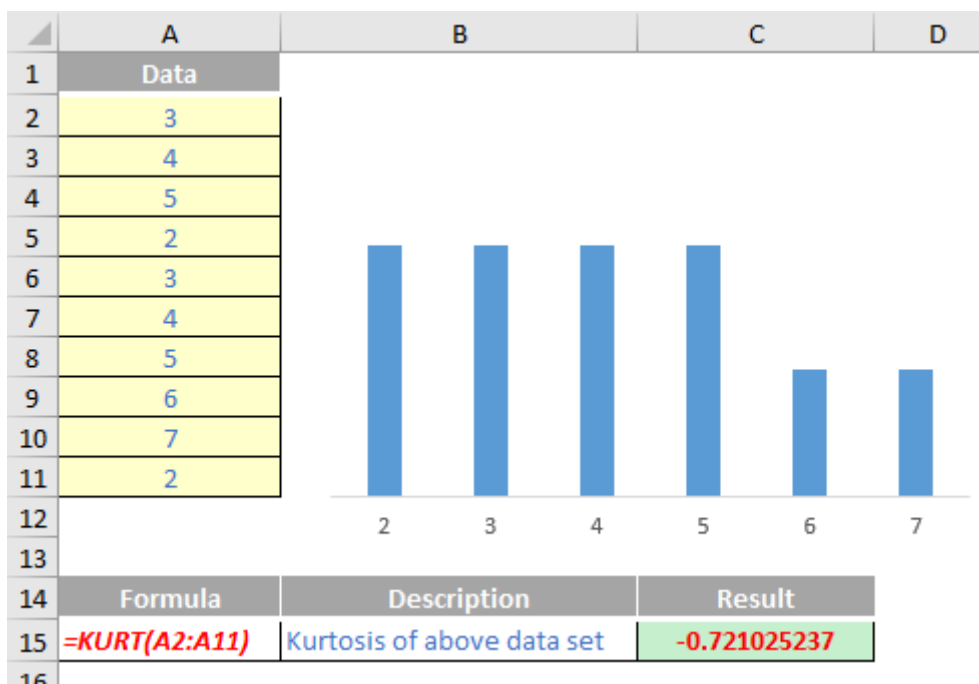
It should be further noted that:

- arguments may be numbers, or names, arrays or references that contain numbers
- logical values and text representations of numbers that you type directly into the list of arguments are counted
- if an array or reference argument contains text, logical values or empty cells, those values are ignored; however, cells with the value zero [0] are included
- arguments that are error values or text that cannot be translated into numbers cause errors
- if there are fewer than four data points, or if the standard deviation of the sample equals zero, **KURT** returns the #DIV/0! error value
- kurtosis is defined as:

$$\left\{ \frac{n(n+1)}{(n-1)(n-2)(n-3)} \sum \left(\frac{x_i - \bar{x}}{s} \right)^4 \right\} - \frac{3(n-1)^2}{(n-2)(n-3)}$$

where s is the sample standard deviation.

Please see my example below:



The A to Z of Excel Functions: LAMBDA

Well, we only seem to write about this function every other month..!

custom functions without code

$(x, y, x+y) \rightarrow 4$

Input names Calculation =myLambda(1, 3)

LAMBDA allows you to define a custom function in Excel's very own formula language. Moreover, one prescribed function may call another. If the function calls itself, that's an example of recursion, which is a way of a function calling itself, called recursion, which is a way... *[get on with it – Ed.]*

As a reminder, there are three key pieces of =**LAMBDA** to understand:

1. **LAMBDA** function components
2. Naming a lambda
3. Calling a lambda function.

1. LAMBDA function components

Let's take a simple example. Consider the following formula:

=LAMBDA(x, x+1)

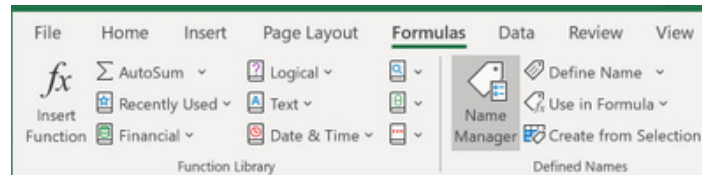
where we have **x** as the argument, which you may pass in when calling the **LAMBDA**, and **x+1** is the logic / operation to be performed. For example, if you were to call this lambda function and define **x** as equal to five (5), then Excel would calculate

$$5 + 1 = 6$$

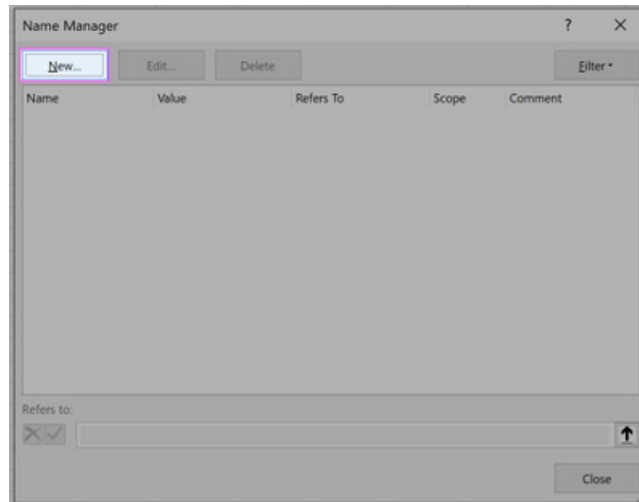
Except it wouldn't. If you tried this you would get **#CALC!** Oops. That's because it's not *quite* as simple as that. You need to name your **LAMBDA**.

2. Naming a lambda

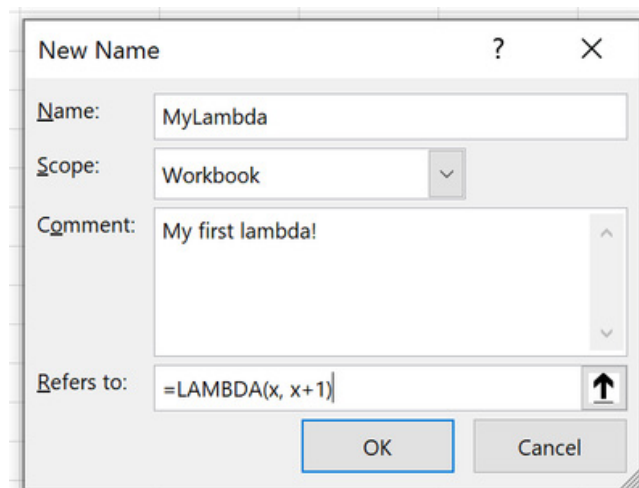
To give your **LAMBDA** a name so it can be re-used, you have to use the Name Manager (**CTRL + F3** / go to the Ribbon and then go to **Formulas -> Name Manager**):



Once you open the Name Manager you will see the following dialog:



You then click on 'New' and fill out the related fields, viz.



It's no harder than clicking 'OK' at this point.

3. Calling LAMBDA

Now that you have done this, your first new lambda function may be called in just the same way as every other Excel function is cited, e.g.

=MYLAMBDA(5)

which would equal six (6) and not #CALC! as before.

You DON'T have to do it this way though if you don't want to. You may call a lambda without naming it. If we hadn't named this marvellous calculation, and simply authored it in the grid as we had first attempted, we could call it by simply typing:

=LAMBDA(x, x+1)(5)

	A	B	C	D
1				
2		6		
3				

This trick won't always work though – and our topic for today is on precisely this issue caused by recursion...

LAMBDA's Aversion to Recursion

To be clear, **LAMBDA** has no aversion; in fact, it enables it. But it makes for a great sub-heading. The “aversion” is that when you use recursion in a **LAMBDA**,

LAMBDA(appropriate syntax)(variable or reference)

may not give the expected result. Instead, it will most likely generate an error, making you think you have written your expression incorrectly. Let me illustrate with a simple example. Consider the following:

	B	C	D	E	F	G	H	I	J
7									
8									
9									
10									
11									
12						9			
13									
14									
15									
16						45			=SUM(G18#)
17									
18						1			=SEQUENCE(G12)
19						2			
20						3			
21						4			
22						5			
23						6			
24						7			
25						8			
26						9			
27									

In cell **G12**, I have typed the number nine (9), which generates the list of numbers one (1) through nine (9) from cell **G18** downwards, using the **SEQUENCE** function, viz.

=SEQUENCE(G12)

For those who recognise this is a dynamic array function and that you require Office 365 at this juncture, you are quite right – but I need Office 365 **Beta** version for the **LAMBDA** functions, so it's OK. I apologise if you don't have Office 365, but again, you might wish to reconsider which version of Excel and Office you are running, in that instance.

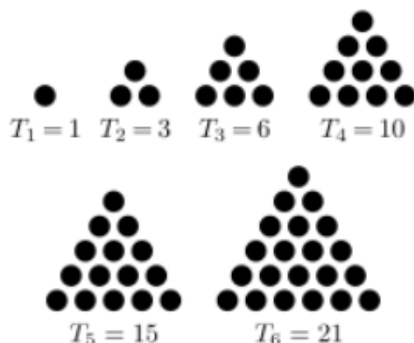
Cell **G16** simply sums this list:

=SUM(G18#)

Therefore, inputting the numbers one (1) through (9) in cell **G12** would generate the results

1, 3, 6, 10, 15, 21, 28, 36, 45, ...

In cell **G16**. These numbers are known as the **triangle numbers**



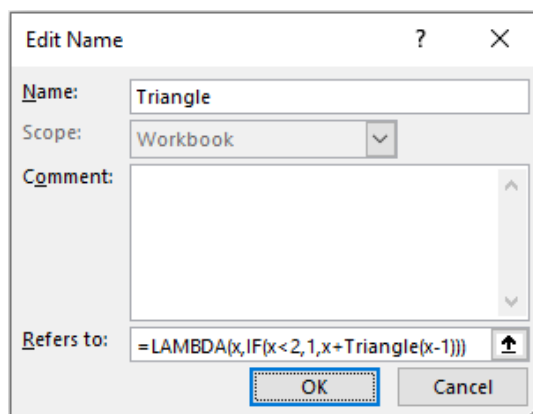
in mathematics, for very obvious reasons.

I want to show you how you can generate this sequence using a **LAMBDA**. Now, yes, I know the formula above works and you can even use the algebraic solution

=G12*(G12+1)/2

too, but the point is here, I want to show you how to create a recursive **LAMBDA** function that is simple to follow.

On the Ribbon, go to the Formulas tab and click on 'Name Manager' (as above) (**CTRL + F3**) and click on the 'New...' button.



I have named my lambda function **Triangle**, and the reference ('Refers to:') is given by

=LAMBDA(x, IF(x<2, 1, x + Triangle(x-1)))

Here, the lambda function takes a parameter **x** and defines it as one (1) if it is less than two (2), else it takes the value **x** and adds the lambda value for **x-1** – hence the recursion. This lambda function has been named **Triangle** (in the 'Name:' box) and is referred to in the formula too.

Therefore, for **x** equals nine (9):

Triangle(9) = 9 + **Triangle(8)**
= 9 + 8 + **Triangle (7)**
= 9 + 8 + 7 + **Triangle (6)**
= 9 + 8 + 7 + 6 + **Triangle(5)**
= 9 + 8 + 7 + 6 + 5 + **Triangle(4)**
= 9 + 8 + 7 + 6 + 5 + 4 + **Triangle(3)**
= 9 + 8 + 7 + 6 + 5 + 4 + 3 + **Triangle(2)**
= 9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + **Triangle(1)**
= 9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + 1
= 45

Drawn out long hand, the recursion is clear.

This presupposes that **x** is an integer, and I have ensured this by incorporating data validation (**Data** -> **Data Validation** or **ALT + D + L**) into my input cell (keep it simple!):

Triangle Numbers

Values

Number

Numerical List

Positive Integer Required
Please enter a whole number greater than zero (0).

Now that the lambda function **Triangle** has been defined, the formula in Excel is easy:

=Triangle(G12)

I have purposely created a simple recursive formula to demonstrate how such a calculation might work. In reality, recursive formulae are likely to be much more sophisticated and / or complex.

Let's assume that wasn't the case though, and you wanted to check whether your formula was working. Not everyone (anyone?) can type a formula and have it work first time, every time. Many of us would want to try the formula in a cell first:

#CALC! =LAMBDA(x,IF(x<2,1,x+Triangle1(x-1)))

Oh dear. That didn't work. Of course it doesn't. As explained above, it needs the parameter (**x**) to be defined:

#NAME? =LAMBDA(x,IF(x<2,1,x+Triangle1(x-1)))(G12)

Rats. This is the problem I alluded to earlier. My definition of the function refers to itself (*i.e.* recursion is exhibited). The name has not yet been defined. Now *watch out* here. Note the function here is **Triangle1**, not **Triangle**. There is a very important distinction. If I use **Triangle**, a similar formula *will* work:

45 =LAMBDA(x,IF(x<2,1,x+Triangle(x-1)))(G12)

This is very easy to explain. I have already defined **Triangle** in the Name Manager! This is why I am using **Triangle1** to avoid this classic *gotcha*.

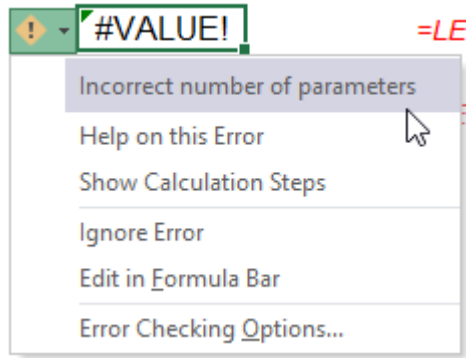
OK, let's define **Triangle1** then. That will mean wrapping the expression in a **LET** function. This allows you to stop writing the same expressions time and time again in a formula, or, as Microsoft puts it, it's "...names on a formula level".

#NAME? =LET(Triangle1,LAMBDA(x,IF(x<2,1,x+Triangle1(x-1))),Triangle1(G12))

This has not worked either, even though **Triangle1** has supposedly been cited by **LET**. The problem is, **Triangle1** has not been defined when we are creating the lambda. This where our trick comes in – which also explains the title for this article: it's all about **ME**. Let's add a parameter (**ME**) to **Triangle1**, and replace the recursive call to **Triangle1** with **ME** (ensuring you pass in **ME** as the first parameter):

#VALUE! =LET(Triangle1,LAMBDA(ME,x,IF(x<2,1,x+ME(ME,x-1))),Triangle1(G12))

Believe it or not, we are getting somewhere now. Even though #NAME? has been replaced with #VALUE!, the formula has evolved. Assuming you have background error checking enabled (File -> Options -> Formulas -> Enable background error checking), you can click on the error to see the issue:



We have an incorrect number of parameters. We have added a parameter to Triangle1 (namely, ME), so the final argument of LET (Triangle1(\$G\$12)) should also have two parameters. We do this by getting Triangle1 to refer to itself, viz.

```
45 =LET(Triangle1,LAMBDA(ME,x,IF(x<2,1,x+ME(ME,x-1))), Triangle1(Triangle1,$G$12))
```

It works! We have checked / debugged our LAMBDA in Excel. We started by calling Triangle1(Triangle1,\$G\$12), and when we evaluate that lambda, we end up calling Triangle1(Triangle1,\$G\$12-1), etc.

Once you've got your head around this, proved for yourself Einstein's Theory of General Relativity and demonstrated Schwarzschild's solution to Einstein's field equations using tensor analysis, you have probably got your lambda working properly! Now, simply remove all references to ME. Exclude ME as the first parameter and replace the ME(calls with the defined name you want to use (here, Triangle1). Therefore, in this instance,

This technique has employed the ME parameter: by passing Triangle1 as a parameter to itself, it can then use that parameter to call itself.

```
=LET(Triangle1, LAMBDA(ME, x, IF(x<2, 1, x + ME(ME, x - 1))), Triangle1(Triangle1, $G$12))
```

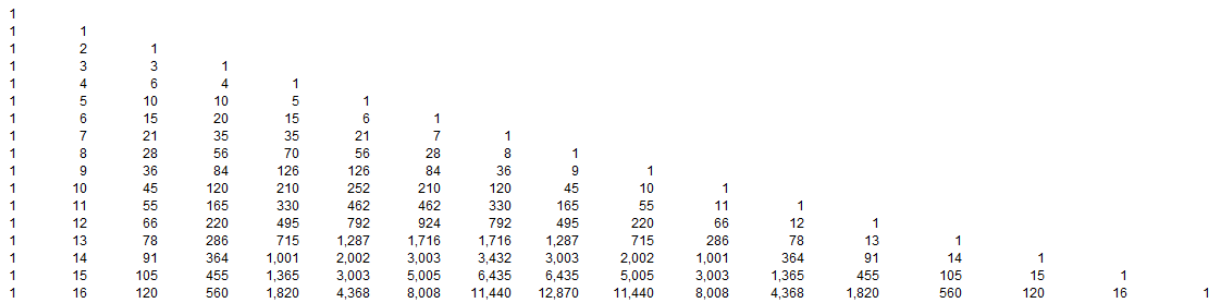
becomes

```
=LAMBDA(x, IF(x<2, 1, x + Triangle1(x - 1)))
```

i.e. we have proved our expression is correct. We can now add this to the Name Manager.

Taking it Further: Pascal's Triangle

Sorry to bring back childhood recollections of mathematics, but triangle (or triangular) numbers feature in Pascal's Triangle:



Starting with a 1 in what is conventionally known as the "zeroth" row (!), each subsequent row's value is calculated as the sum of the cell directly above it and the cell to the left of the cell above the cell you are in. Notice the triangle numbers occur in both the third column and the third diagonal from the top.

This is an almost "ultimate" recursion, as you can trace any number on any row back through its constituent elements higher up the Triangle. Note that this beast is useful in mathematics as this array displays the binomial coefficients of (x + 1)^n. For example:

- (x + 1)^0 = 1 – which is the coefficient on the zeroth (0th) row
- (x + 1)^1 = x + 1 = 1x + 1 – the coefficients 1 and 1 are on row 1 of Pascal's Triangle
- (x + 1)^2 = x^2 + 2x + 1 = 1x^2 + 2x + 1 – the coefficients 1, 2 and 1 are on row 2 of Pascal's Triangle
- (x + 1)^3 = x^3 + 3x^2 + 3x + 1 = 1x^3 + 3x^2 + 3x + 1 – the coefficients 1, 3, 3 and 1 are on row 3 of Pascal's Triangle, etc.

Now, yes, I know, Excel has a function that calculates these coefficients – and hence any element of Pascal's Triangle. If you are often COMBIN the Excel functions to see how many subsets you can make, then COMBIN is for you. This function returns the number of combinations for a given

number of items (i.e. the number of distinct subsets of items where order is unimportant). You should use COMBIN to determine the total possible number of groups for a given number of items.

The **COMBIN** function employs the following syntax to operate:

COMBIN(number, number_chosen)

The **COMBIN** function has the following arguments:

- **number**: this is required and represents the number of items
- **number_chosen**: this is also required. This denotes the number of items in each combination.

However, in the context of Pascal's Triangle, it may be seen to be

COMBIN(row_number, column_number)

where both **row_number** and **column_number** start at zero, rather than one for the reasons demonstrated above.

The technique for calculating this using a recursive lambda function is very similar to the **Triangle** example (*above*). You can define **Pascal** in the Name Manager (**CTRL + F3**) as

=LAMBDA(row_num, col_num, IF(OR(row_num < 0, col_num < 0), 0, IF(row_num = 0, IF(col_num = 0, 1, 0), Pascal(row_num - 1, col_num - 1) + Pascal(row_num - 1, col_num))))

This may be checked in a cell using the **ME** technique (*as above*):

=LET(Pascal1, LAMBDA(ME, row_num, col_num, IF(OR(row_num < 0, col_num < 0), 0, IF(row_num = 0, IF(col_num = 0, 1, 0), ME(ME, row_num - 1, col_num - 1) + ME(ME, row_num - 1, col_num)))), Pascal1(Pascal1, \$I\$12, \$I\$13))

Alternative Approaches to Calculating Pascal's Triangle Element		
Assumptions		
Row and Column Numbers		
Row Number	30	
Column Number	8	
Alternative Calculations		
Excel Functions		
Output Value using INDEX	5,852,925	=IFERROR(INDEX(Pascal's Triangle!\$F\$12:\$A:\$42,\$I\$12+1,\$I\$13+1),)
Output Value using COMBIN	5,852,925	=IFERROR(COMBIN(\$I\$12,\$I\$13),)
LAMBDA Approach		
Using LAMBDA from Name Manager	5,852,925	=Pascal(112,113)
Equivalent formula in Name Manager	#CALC!	=LAMBDA(row_num,col_num,IF(OR(row_num<0,col_num<0),0,IF(row_num=0,IF(col_num=0,1,0),Pascal(row_num-1,col_num-1)+Pascal(row_num-1,col_num))))
Equivalent formula with reference	#NAME?	=LAMBDA(row_num,col_num,IF(OR(row_num<0,col_num<0),0,IF(row_num=0,IF(col_num=0,1,0),Pascal(row_num-1,col_num-1)+Pascal(row_num-1,col_num))))(112,113)
Using LET	#NAME?	=LET(Pascal,LAMBDA(row_num,col_num,IF(OR(row_num<0,col_num<0),0,IF(row_num=0,IF(col_num=0,1,0),Pascal(row_num-1,col_num-1)+Pascal(row_num-1,col_num))))),Pascal(\$I\$20,\$I\$21))
Adding ME	#VALUE!	=LET(Pascal,LAMBDA(ME,row_num,col_num,IF(OR(row_num<0,col_num<0),0,IF(row_num=0,IF(col_num=0,1,0),ME(ME,row_num-1,col_num-1)+ME(ME,row_num-1,col_num))))),Pascal(\$I\$20,\$I\$21))
Corrected and checked	5,852,925	=LET(Pascal,LAMBDA(ME,row_num,col_num,IF(OR(row_num<0,col_num<0),0,IF(row_num=0,IF(col_num=0,1,0),ME(ME,row_num-1,col_num-1)+ME(ME,row_num-1,col_num))))),Pascal(Pascal,\$I\$12,\$I\$13))
		Values are equal

This **Pascal** lambda function is a more complex example of recursion that highlights an important design consideration. On my reasonably powerful computer, when I tried to select an element from row 30 of Pascal's Triangle, Excel took c.55 seconds to calculate, due to all the interim recursive calculations.

Be careful. Lambda calculations in Excel are very fast, but if you adopt an excessive recursive approach as I have done here, any powerful PC will be slowed down to a "crawling speed". The problem here is that the calculation speed in this instance is proportional to $4^n / \sqrt{n}$, where n is the row number.

A better lambda might be **Pascal_Row**, where the time taken is proportional to n^2 :

=LAMBDA(a, b, LET(Pascal_Row, LAMBDA(ME, x, IF(x=0, 1, IF(x=1, {1, 1}, LET(seq, SEQUENCE(x + 1), previous_row, ME(ME, x - 1), shifted, IF(seq=1, 0, INDEX(previous_row, 1, seq - 1)), IFERROR(previous_row + shifted, 1))))), INDEX(Pascal_Row(Pascal_Row, a), 1, b + 1)))

This is achieved by calculating on a row, rather than an element, basis.

But even this may be improved upon. Consider **Pascal_Fast**:

=LAMBDA(n, k, IF(k * 2 > n, Pascal_Fast(n, n - k), IF(k = 0, 1, LET(gcd_cutoff, 2 ^ 53 / n, previous, Pascal_Fast(n, k - 1) * (n + 1 - k) / k, IF(n <= gcd_cutoff, previous, LET(gcd, GCD(previous, k), remainder, k / gcd, previous / gcd * ((n + 1 - k) / remainder))))))

This is very quick compared to both of the previous alternatives, as the time here is proportional to just n , the row number. The problem as you may have noticed here, is that as you maximise the iterative approach,

the transparency of the calculation – for the average user – tends to become more and more opaque. PhDs in Computer Science are available upon request.

As a compromise, perhaps

$$=LAMBDA(n, k, IF(k=0, 1, Pascal_Almost_As_Fast(n, k - 1) * (n + 1 - k) / k))$$

{Pascal_Almost_As_Fast} might work best, which takes approximately twice as long as the above monster (i.e. “almost” instantly).

Care with IFS and SWITCH

Given how calculations may “blow out” quickly when creating iterative functions, it’s best to avoid another classic *gotcha*. Let me illustrate with one of the best-known iterative sequences, the Fibonacci sequence:

1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, ...

This sequence is calculated as $F_n = F_{n-1} + F_{n-2}$.

You might choose to define a lambda function using IFS as follows:

$$=LAMBDA(x, IFS(x=1, 1, x = 2, 1, TRUE, Fibonacci(x - 1) + Fibonacci(x - 2)))$$

If you are starting to follow lambdas, you should see this appears to make sense (the final argument of IFS, given the criterion is simply TRUE, resorts to advising what to do when x is neither equal to one (1) nor two (2)). There is a problem though. This function will run forever, since each parameter in this IFS statement must be evaluated before IFS gets evaluated. Therefore, when evaluating Fibonacci(1), it will try to evaluate Fibonacci(0) + Fibonacci(-1), and so on. Not good!

Therefore, you should use IF instead:

$$=LAMBDA(x, IF(x = 1, 1, IF(x = 2, 1, Fibonacci(x - 1) + Fibonacci(x - 2))))$$

as IF does not evaluate a parameter it does not return.

Be advised, SWITCH exhibits a similar such property, and you should choose to use CHOOSE instead.

Fibonacci Sequence

Values

Number

Numerical List

1
1
2
3
5
8
13
21
34
55
89
144
233
377
610
987
1597
2584
4181
6765

=OFFSET(\$G\$17,\$G\$12,)

Algebraic Alternative

=1/SQRT(5)*(((1+SQRT(5))/2)^\$G\$12-((1-SQRT(5))/2)^\$G\$12)

LAMBDA Approach

=Fibonacci(\$G\$12)

#CALC!

=LAMBDA(x,IF(x=1,1,IF(x=2,1,Fibonacci(x-1)+Fibonacci(x-2))))

#NAME?

=LAMBDA(x,IF(x=1,1,IF(x=2,1,Fibonacci(x-1)+Fibonacci(x-2))))(\$G\$12)

#NAME?

=LET(Fibonacci1,LAMBDA(x,IF(x=1,1,IF(x=2,1,Fibonacci(x-1)+Fibonacci(x-2))))),Fibonacci1(\$G\$12))

#VALUE!

=LET(Fibonacci1,LAMBDA(ME,x,IF(x=1,1,IF(x=2,1,ME(ME,x-1)+ME(ME,x-2))))),Fibonacci1(\$G\$12))

=LET(Fibonacci1,LAMBDA(ME,x,IF(x=1,1,IF(x=2,1,ME(ME,x-1)+ME(ME,x-2))))),Fibonacci1(Fibonacci1,\$G\$12))

Faster approach

Values are equal

Just to highlight the point earlier about optimisation, the Fibonacci lambda function may be improved upon too – again, at the risk of mathematical / formulaic comprehension:

$$=LAMBDA(n, LET(Fibonacci_Faster, LAMBDA(ME, x, F_1, F, current, IF(x <= 2, 1, IF(x = current, F, ME(ME, x, F, F_1 + F, current + 1))))), Fibonacci_Faster(Fibonacci_Faster, n, 1, 1, 2)))$$

Now you have something to study the next time you are stranded on a desert island.

Word to the Wise

Playing with new functions is highly addictive and can lead you to using them when they are **not** needed. No matter how optimised recursive calculations are, I strongly advise that if you don't need them, don't use them. Formulaic alternatives, such as **COMBIN** for Pascal's Triangle are instant and simple, to the naked eye.

Furthermore, do note that the current operand stack limit in Excel is 1,024. This should be borne in mind together with calculation times, as the current recursion limit is set as 1,024 divided by (number of lambda parameters + 1).

More Excel Functions next month.

Finally, some common problems faced in financial modelling are **not** recursive in nature, so try not to confuse the issue unnecessarily. For example, the most common financial modelling illustration is the calculation of interest on an average cash balance. This is actually an instance of solving two simultaneous equations. Applying recursive logic would be inappropriate.

Beat the Boredom Suggested Solution

The challenge presented earlier in this newsletter was to generate the list of the five most recent items using Excel formulae.

Of course, we used an example. There was an **Order_Database** data set which contained details of **Customer Name**, **Order Date** and **Order Volume** over the time, viz.

	A	B	C	D	E	F	G	H	I
1	Customer Name	Order Date	Order Volume						
2	Harris	28/01/2021	353				Customer	Jones Financial (Edward Jones)	
3	Avnet	21/01/2021	929						
4	Las Vegas Sands	19/01/2021	479				Last five orders:		
5	Sherwin-Williams	18/01/2021	360				Order Date	Order Volume	
6	Mastercard	13/01/2021	202		1			-	
7	Alcoa	13/01/2021	612		2			-	
8	Ford Motor	11/01/2021	482		3			-	
9	Mastercard	6/01/2021	830		4			-	
10	Jones Financial (Edward Jo	5/01/2021	777		5			-	
11	Old Republic International	3/01/2021	460				Average	-	
12	Owens Corning	3/01/2021	639						
13	Jones Financial (Edward Jo	1/01/2021	480						
14	Ford Motor	31/12/2020	932						
15	Fidelity National Financial	31/12/2020	320						
16	Avnet	31/12/2020	282						
17	Owens & Minor	27/12/2020	620						
18	Intuit	27/12/2020	589						
19	Caterpillar	26/12/2020	424						
20	Markel	25/12/2020	453						
21	Avnet	23/12/2020	629						
22	Ford Motor	23/12/2020	472						
23	Intuit	20/12/2020	219						
24	Charter Communications	18/12/2020	529						
25	Intuit	14/12/2020	403						
26	Fidelity National Financial	13/12/2020	755						

To facilitate the conversation with customers upon placing an order, the operator wants to view the five most recent orders from that customer. Specifically, when a customer is selected from the list in cell **H2** (see image above), their last five order dates will appear in cells **G6:G10** in descending order, together with the corresponding order volumes.

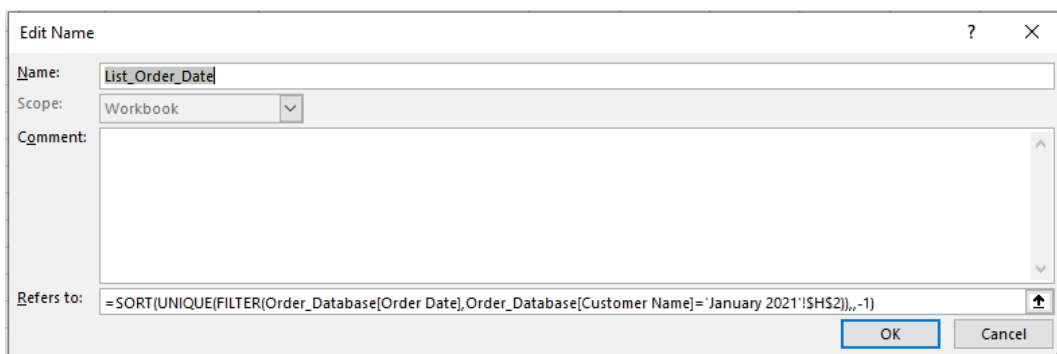
The challenge was simple: could you get the list in cells **G6:G10** in just **two** steps?

Suggested Solution

Step 1: Create a Dynamic Range Name using a formula

Navigate to the Formulas tab on the Ribbon and select 'Define Name'. In the 'New Name' dialog, the **List_Order_Date** range name should be created using the formula below:

```
=SORT(UNIQUE(FILTER(Order_Database[Order Date],Order_Database[Customer Name]='January 2021'!$H$2)),,-1)
```



Yes, we are using the **dynamic array formulae** to make it work, so we understand this is a solution for Office 365. However, we should avail ourselves of all the features available in modern Excel.

Let's break the formula into digestible pieces to understand how it works:

- the **FILTER** function will get the list of all dates related to the customer selected in cell **H2**
- a customer may make multiple orders in a day, so the **UNIQUE** function will return no duplicates in the list of dates
- therefore, the **SORT** function will arrange this list based upon descending order (as seeing the most recent order first probably makes the most sense).

A	B	C	D	E	F	G	H	I	J	K	L	M
1	Customer Name	Order Date	Order Volume									
2	Harris	28/01/2021	353				Customer	Owens & Minor				
3	Avnet	21/01/2021	929									
4	Las Vegas Sands	19/01/2021	479				Last five orders:					
5	Sherwin-Williams	18/01/2021	360				Order Date	Order Volume				
6	Mastercard	13/01/2021	202		1	27/12/2020		620				
7	Alcoa	13/01/2021	612		2	13/12/2020		526				
8	Ford Motor	11/01/2021	482		3	7/12/2020		997				
9	Mastercard	6/01/2021	830		4	3/11/2020		894				
10	Jones Financial (Edward Jo	5/01/2021	777		5	30/10/2020		804				
11	Old Republic International	3/01/2021	460			Average		768				
12	Owens Corning	3/01/2021	639									
13	Jones Financial (Edward Jo	1/01/2021	480									
14	Ford Motor	31/12/2020	932			27/12/2020						
15	Fidelity National Financial	31/12/2020	320			13/12/2020						
16	Avnet	31/12/2020	282			7/12/2020						
17	Owens & Minor	27/12/2020	620			3/11/2020						
18	Intuit	27/12/2020	589			30/10/2020						
19	Caterpillar	26/12/2020	424			26/10/2020						
20	Markel	25/12/2020	453			8/08/2020						
21	Avnet	23/12/2020	629									
22	Ford Motor	23/12/2020	472									
23	Intuit	20/12/2020	219									
24	Charter Communications	18/12/2020	529									
25	Intuit	14/12/2020	403									
26	Fidelity National Financial	13/12/2020	712									

Step 2: Get the list of last five order dates using the INDEX function

Given the **List_Order_Date**, the cells **G6:G10** may be filled using the **INDEX** function. In case the list of historical order date related to the customer is less than five (5), the formula should return a blank, viz.

=IFERROR(INDEX(List_Order_Date,F6),"")

F	G	H	I	J	K	L	M	N
	Customer	Owens & Minor						
	Last five orders:							
	Order Date	Order Volume						
1	27/12/2020	620						
2	13/12/2020	526						
3	7/12/2020	997						
4	3/11/2020	894						
5	30/10/2020	804						
	Average	768						
	=IFERROR(INDEX(List_Order_Date,F6),"")							
	=SUMIFS(Order_Database[Order Volume],Order_Database[Customer Name],\$H\$2,Order_Database[Order Date],G6)							

Hence, the order volume can be calculated using the **SUMIFS** function:

=SUMIFS(Order_Database[Order Volume], Order_Database[Customer Name], \$H\$2, Order_Database[Order Date], G6)

Until next time.

Upcoming SumProduct Training Courses - COVID-19 update

Due to the COVID-19 pandemic that is currently spreading around the globe, we are suspending our in-person courses until further notice. However, to accommodate the new working-from-home dynamic, we are switching our public and in-house courses to an online delivery stream, presented via Microsoft Teams, with a live presenter running through the same course material, downloadable workbooks to complete the hands-on exercises during the training session, and a recording of the sessions for

your use within 1 month for you to refer back to in the event of technical difficulties. To assist with the pacing and flow of the course, we will also have a moderator who will help answer questions during the course.

If you're still not sure how this will work, please contact us at training@sumproduct.com and we'll be happy to walk you through the process.

Location	Course	Date	Date	Duration	Duration
Online (Australia)	Power Pivot, Power Query and Power BI	12 - 14 Apr 2023	09:00-17:00 AEST	(-1 day) 23:00-17:00 GMT	3 Days
Online (Australia)	Excel Tips and Tricks	19 Apr 2023	09:00-17:00 AEST	(-1 day) 23:00-17:00 GMT	1 Day
Online (Australia)	Financial Modelling	20 - 21 Apr 2023	09:00-17:00 AEST	(-1 day) 23:00-17:00 GMT	2 Days
Online (Australia)	Power Pivot, Power Query and Power BI	10 - 12 May 2023	09:00-17:00 AEST	(-1 day) 23:00-17:00 GMT	3 Days
Online (Australia)	Excel Tips and Tricks	17 May 2023	09:00-17:00 AEST	(-1 day) 23:00-17:00 GMT	1 Day
Online (Australia)	Financial Modelling	18 - 19 May 2023	09:00-17:00 AEST	(-1 day) 23:00-17:00 GMT	2 Days
Online (Australia)	Power Pivot, Power Query and Power BI	7 - 9 Jun 2023	09:00-17:00 AEST	(-1 day) 23:00-17:00 GMT	3 Days
Online (Australia)	Excel Tips and Tricks	14 Jun 2023	09:00-17:00 AEST	(-1 day) 23:00-17:00 GMT	1 Day
Online (Australia)	Financial Modelling	15 - 16 Jun 2023	09:00-17:00 AEST	(-1 day) 23:00-17:00 GMT	2 Days

Key Strokes

Each newsletter, we'd like to introduce you to useful keystrokes you may or may not be aware of. This month, we look at the **CTRL** and **ALT** keys:

Keystroke	What it does
CTRL + SHIFT + 0	Show column
CTRL + SHIFT + 1	Fixed decimal and comma format
CTRL + SHIFT + 2	Time (AM/PM) format
CTRL + SHIFT + 3	Date format
CTRL + SHIFT + 4	Currency format
CTRL + SHIFT + 5	Percentage format
CTRL + SHIFT + 6	Exponential format
CTRL + SHIFT + 7	Outline border
CTRL + SHIFT + 8	Select current region
CTRL + SHIFT + 9	Unhide row

There are c.550 keyboard shortcuts in Excel. For a comprehensive list, please download our Excel file at www.sumproduct.com/thought/keyboard-shortcuts. Also, check out our new daily **Excel Tip of the Day** feature on the www.sumproduct.com homepage.

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We have undertaken a vast array of assignments over the years, including:

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- **Key driver analysis**
- **Model reviews / audits for internal and external purposes**
- **M&A work**
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- **Project finance**
- **Real options analysis**
- **Refinancing / restructuring**
- **Strategic modelling**
- **Valuations**
- **Working capital management**

If you require modelling assistance of any kind, please do not hesitate to contact us at contact@sumproduct.com.

Link to Others

These newsletters are not intended to be closely guarded secrets. Please feel free to forward this newsletter to anyone you think might be interested in converting to "the SumProduct way".

If you have received a forwarded newsletter and would like to receive future editions automatically, please subscribe by completing our newsletter registration process found at the foot of any www.sumproduct.com web page.

Any Questions?

If you have any tips, comments or queries for future newsletters, we'd be delighted to hear from you. Please drop us a line at newsletter@sumproduct.com.

Training

SumProduct offers a wide range of training courses, aimed at finance professionals and budding Excel experts. Courses include Excel Tricks & Tips, Financial Modelling 101, Introduction to Forecasting and M&A Modelling.

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