MICROSOFT EXCEL:

FORMULAS & FUNCTIONS

★★★★★ *With 5 Star Excel instructor* ***Hakeem Falade***

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

COURSE OUTLINE

1 Excel Formulas 101	*Syntax, reference types, errors, auditing, shortcuts, etc.*
2 Conditionals & Logical Operators	*IF, AND, OR, NOT, ISERROR, ISNUMBER, etc.*
3 Basic Statistical Functions	*MAX/MIN, RANK, RAND(), SUMIFS/COUNTIFS, SUMPRODUCT, etc.*
4 Lookup/Reference Functions	*VLOOKUP/HLOOKUP, INDEX/MATCH, OFFSET, etc.*
5 Text Formulas	*TEXT/VALUE, LEFT/MID/RIGHT, SEARCH, TRIM, LEN, etc.*
6 Date & Time Functions	*DATEVALUE, TODAY/NOW, DATEDIF, YEARFRAC, EOMONTH, etc.*
7 Formula-Based Formatting	*Creating, editing, and managing formula-driven formatting rules*
8 Array Formulas	*Vertical/Horizontal arrays, double unary, TRANSPOSE, etc.*
9 Extra Bonus Functions	*HYPERLINK, INDIRECT, WEBSERVICE, FILTERXML, etc.*

SETTING EXPECTATIONS

1. We'll be using Excel for **Windows/PC** (Excel 2013-2019)
   - *What you see on your screen **will not always match** mine, especially if you're using an older version of Excel*

2. We'll focus on many of Excel's most **powerful**, **widely-used** functions
   - *Excel's formula library includes nearly **500 functions**; we won't cover some of the more specialized categories (like Financial or Engineering functions), or those which require knowledge outside the scope of this course*

3. The goal of this course is to help you **master the building blocks**
   - *The beauty of Excel formulas is that no matter how complex they get, they're ALL comprised of simple pieces. We'll start by mastering each individual component before combining them in more complex ways*

4. Feeling stuck? **We've got your back.**
   - *If you have questions about the course material, feel free to post a question and we'll be happy to help*
   - *For project-specific questions, recommend posting to the **answers.microsoft.com** community forum*

FORMULAS 101

*All formulas start with an **equals sign***

*Arguments are always surrounded by **parentheses***

*Arguments are separated by **commas** in the US, but other regions may use different list separators (like **semi-colons**)*

=MATCH(lookup_value, lookup_array, [match_type])

The **function name** tells Excel what type of operation you're about to perform *(Excel offers ~500 functions)*

Note: Function names aren't case-sensitive, and aren't always required; basic arithmetic and logical operations often don't need one:

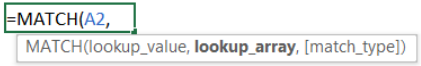
- *=A1 +B1*
- *=A1 /B1*
- *=A1 >B1*
- *=A1 =B1*

These are **arguments**, which vary by function and provide Excel with the info needed to evaluate a result

Note: Not all arguments are required; optional arguments are surrounded by square brackets *(like **[match_type]** above)*

Most functions have at least one required argument, but some don't require any, like **ROW()**, **COLUMN()**, **TODAY()** or **NOW()**

PRO TIP:



*As you begin writing a formula, the **Function ScreenTips** box will guide you through each individual argument – this is an extremely helpful tool!*

Reference types allow you to "recycle" formulas across multiple cells, without having to manually update your references (which would be completely impractical)

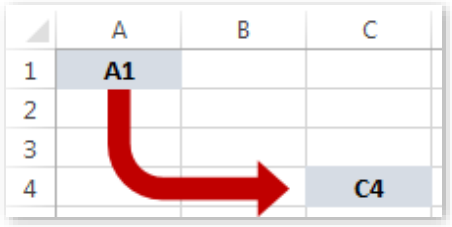
Cell references are **relative** by default (A1). This **allows the reference to change** as the formula is copied to new cells

The **$** symbol is used to create **fixed** references. You can fix entire cells ($A$1) or just the column ($A1) or row (A$1), which **prevents references from changing** as the formula is copied to new cells

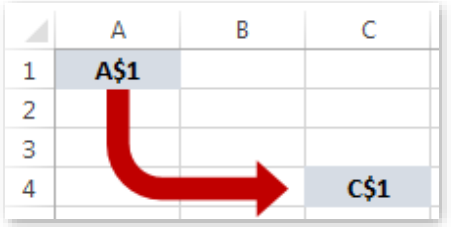
PRO TIP:

*Mastering reference types is my **#1 tip** for working efficiently with formulas*

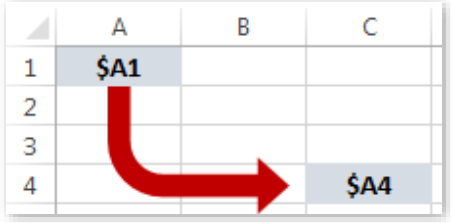
Relative Column & Row



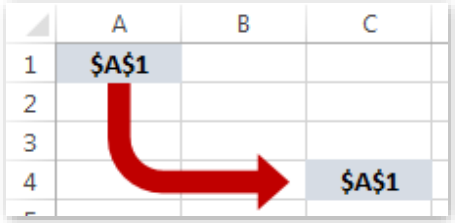
Relative Column, Fixed Row



Fixed Column, Relative Row



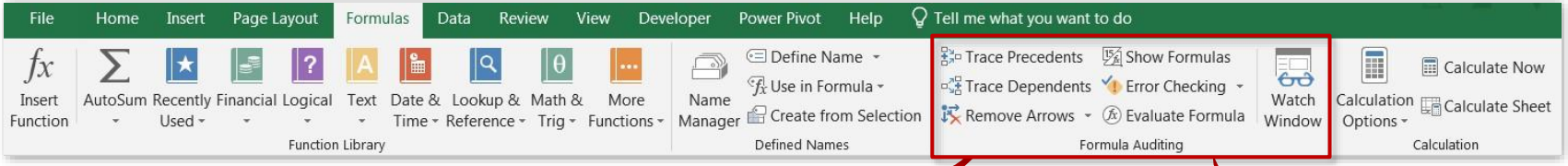
Fixed Column & Row



Common Errors

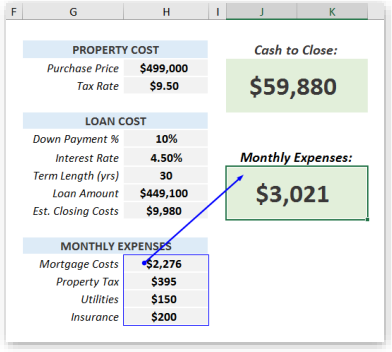
Error Type	What it means	How to fix it
#######	Column isn't wide enough to display values	*Drag or double-click column border to increase width, or right-click to set custom column width*
#NAME?	Excel does not recognize text in a formula	*Make sure that function names are correct, references are valid and spelled properly, and quotation marks and colons are in place*
#VALUE!	Formula has the wrong type of argument	*Check that your formula isn't trying to perform an arithmetic operation on text strings or cells formatted as text*
#DIV/0!	Formula is dividing by zero or an empty cell	*Check the value of your divisor; if 0 is correct, use an IF statement to display an alternate value if you choose*
#REF!	Formula refers to a cell that is not valid	*Make sure that you didn't move, delete, or replace cells that are referenced in your formula*
#N/A	Formula can't find a referenced value	*Check that all references and formula arguments evaluate properly (the most common cause is a lookup value with no match)*

Auditing Tools



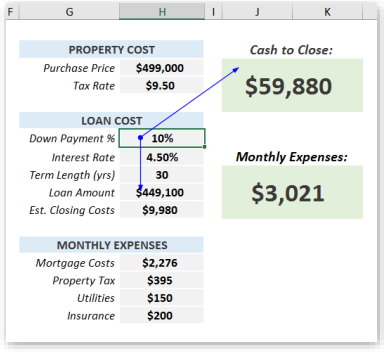
Trace Precedents

Identifies cells which **affect** the value of the one selected



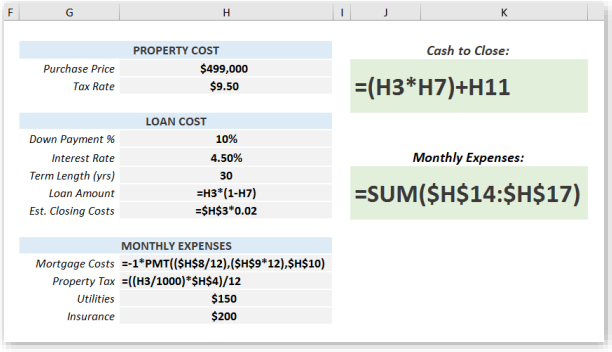
Trace Dependents

Identifies cells which **are affected by** the value of the one selected



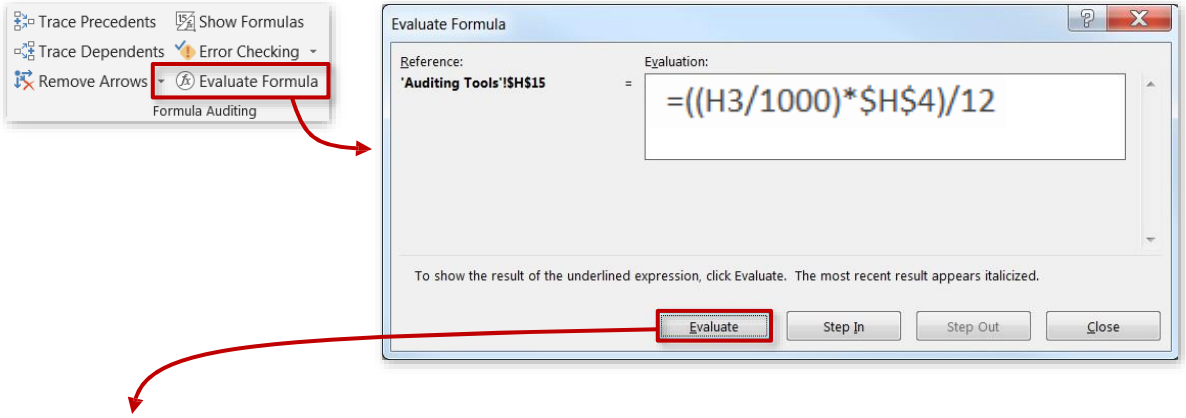
Show Formulas

Temporarily displays all formulas in the worksheet as **text strings**



TIP: *To select all cells containing formulas, use **Ctrl-G** to launch the Go-To menu, then select **Special > Formulas***

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY



Evaluate Formula

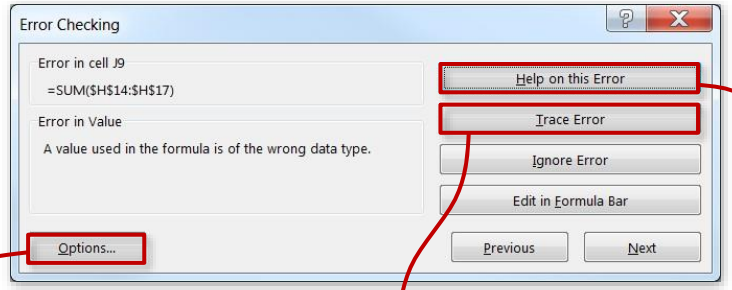
Allows you to cycle through each individual calculation step within a formula, see how each component evaluates, and pinpoint the source of the error

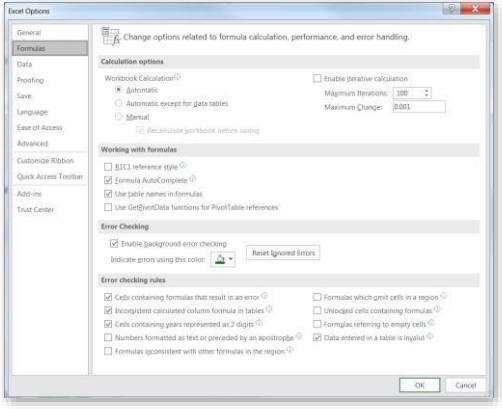
PRO TIP:

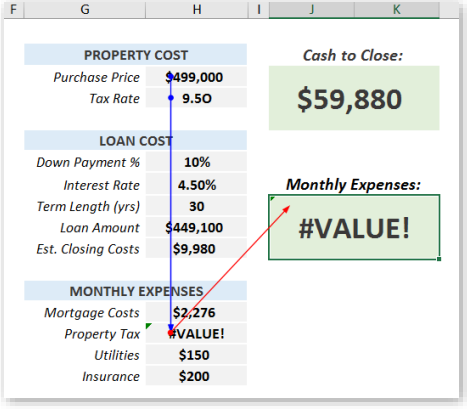
*Evaluate Formula is my **go-to tool** for breaking down complex or unfamiliar formulas*

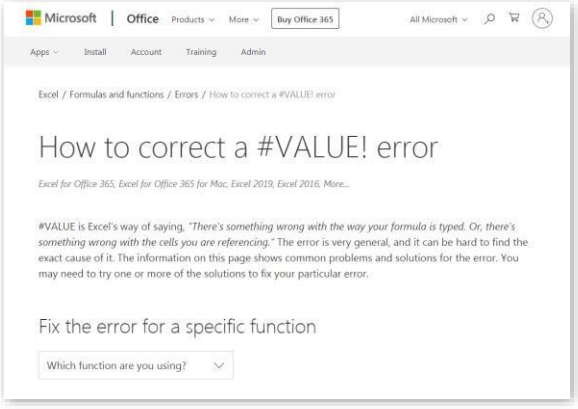
Error Checking

Scans the sheet for errors and provides a summary with options to trace the source, ignore the error, modify your options, or link out to Microsoft support









Ctrl + Arrow

- **Jumps to the last cell** in a data region, in the direction of the arrow

Ctrl + Shift + Arrow

- **Selects to the last cell** in a data region, in the direction of the arrow

Ctrl + Home/End

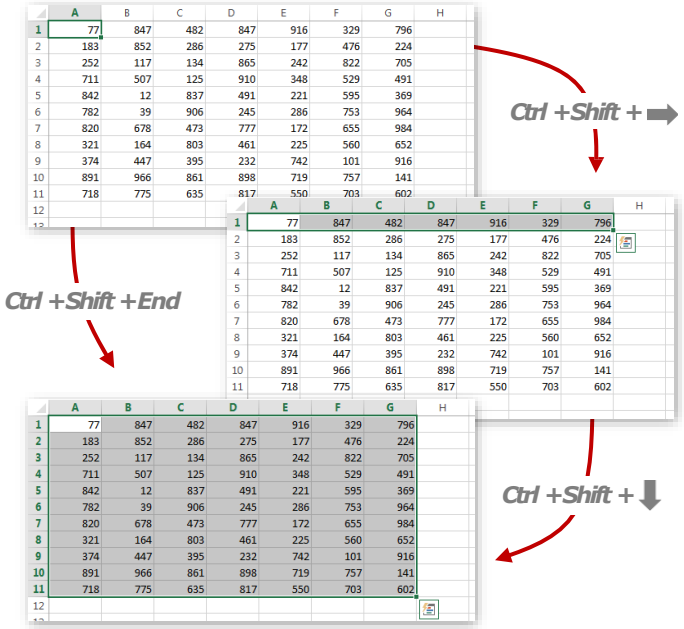
- Jumps to the **Home** (*top-left*) or **End** (*bottom-right*) cell in a region

Ctrl + .

- Jumps straight to **each corner** within a selected cell range

Ctrl + PgUp/PgDn

- **Switches worksheet tabs**, either to the **left** (*PgUp*) or **right** (*PgDn*)



FULL LIST: https://exceljet.net/keyboard-shortcuts

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

F1

- Launches the **Excel help** pane *(default)*
- Links to the **Microsoft Support** website *(tool-specific)*

F2

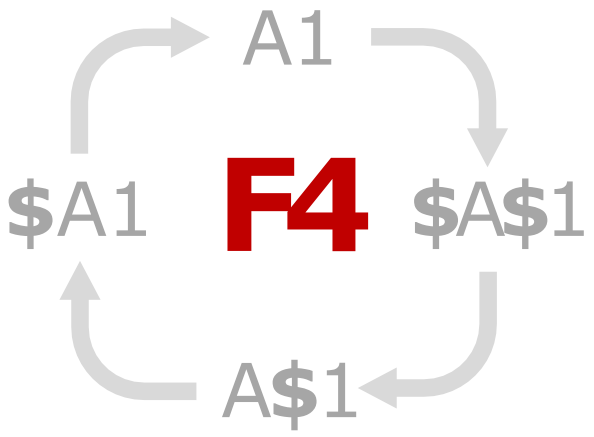
- Allows you to **edit** the active cell
- Highlights cells referenced by the active formula

F4

- Repeats the **last action** taken *(default)*
- Toggles **absolute/relative** cell references within a formula

F9

- Calculates all workbook formulas *(when in **manual** mode)*
- Evaluates **each function argument** within the formula bar



INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

FULL LIST: https://exceljet.net/keyboard-shortcuts

Common Mac Shortcuts

Mac Shortcut	Purpose	PC Equivalent
Command-T	*Cycles between cell reference types*	**F4**
Command-Y	*Repeats the last user action*	**F4**
Control-U	*Displays cell ranges tied to a given formula*	**F2**
Command-Arrow	*Jumps to the edge of a contiguous data array*	**CTRL-ARROW**
Command-Shift-Arrow	*Extends a selection to the edge of a data array*	**CTRL-SHIFT-ARROW**
Command-Fn-Up/Down	*Jumps between workbook tabs*	**CTRL-PAGE UP/DOWN**

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

FULL LIST: https://exceljet.net/keyboard-shortcuts

Alt Key Tips

- Allow you to quickly access tools from ribbon menus and sub-menus using only the **keyboard** *(no clicks!)*
- Each keystroke takes you a layer deeper, until you land on the tool you need *(**Note**: Simply **press & release** the Alt key, instead of holding it down)*
- There are hundreds of combinations, so start by focusing on the tools that you use most frequently:

Some of my go-to key tips

Alt – H – V – V

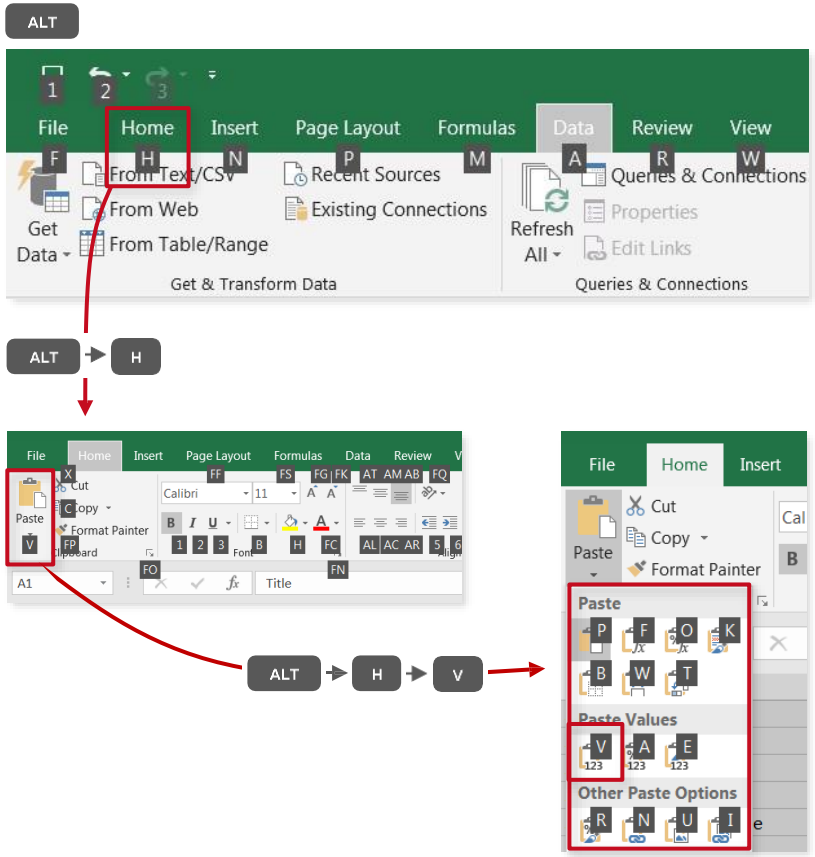
- Paste Special as Values

Alt – A – T

- Add or remove filters

Alt – M – V

- Evaluate Formula



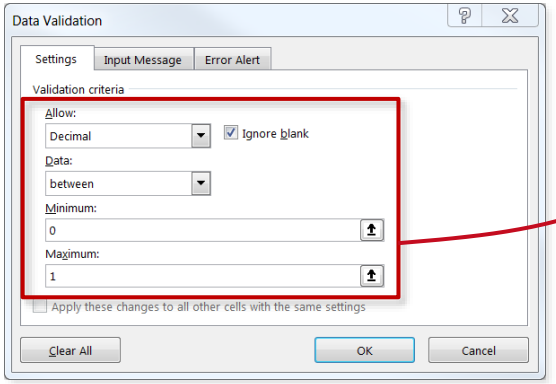
INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

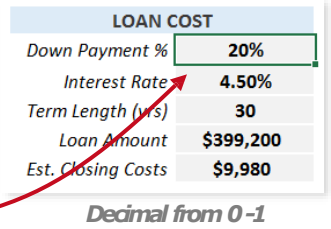
Data Validation

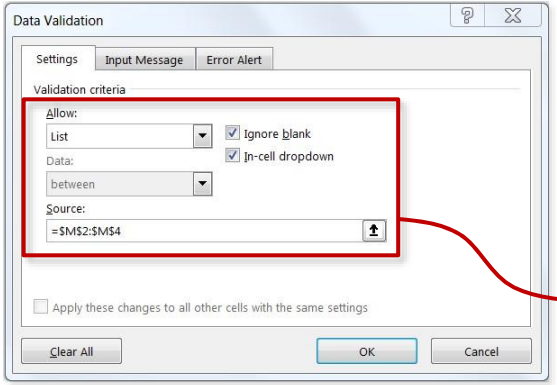
Restricts the values that a user can enter into a given cell, based on:

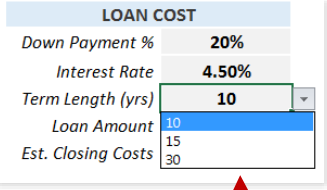
- **Number Type** *(Whole vs. Decimal)*
- **Value** *(Between, Less Than, Equal To, etc)*
- **List of Items** *(Based on cell range or manual list)*
- **Date/Time** *(Between, Less Than, Equal To, etc)*
- **Text Length** *(Between, Less Than, Equal To, etc)*
- **Custom** *(Formula-Driven)*

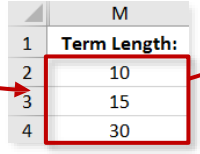
FUN FACT: You can customize your own **error alerts**!





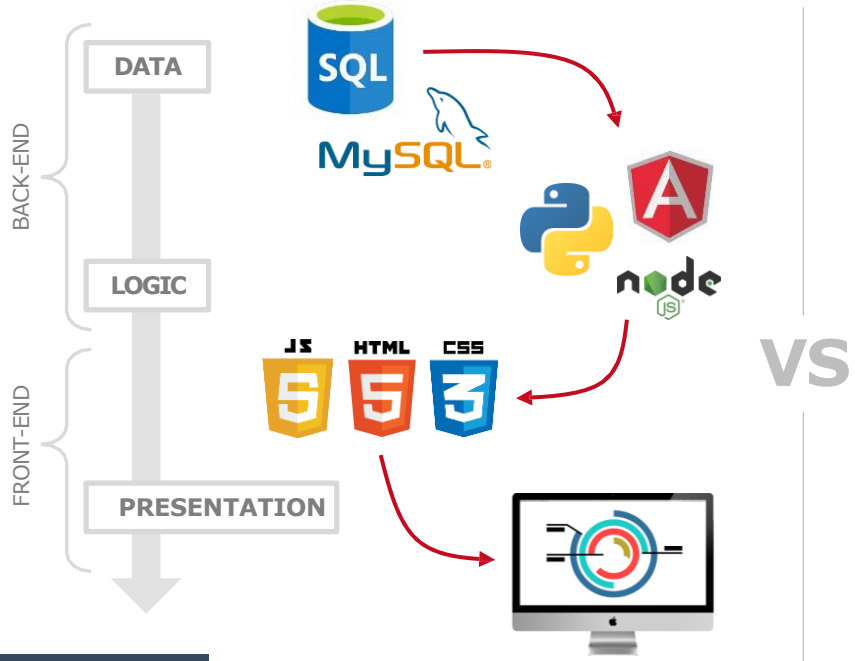




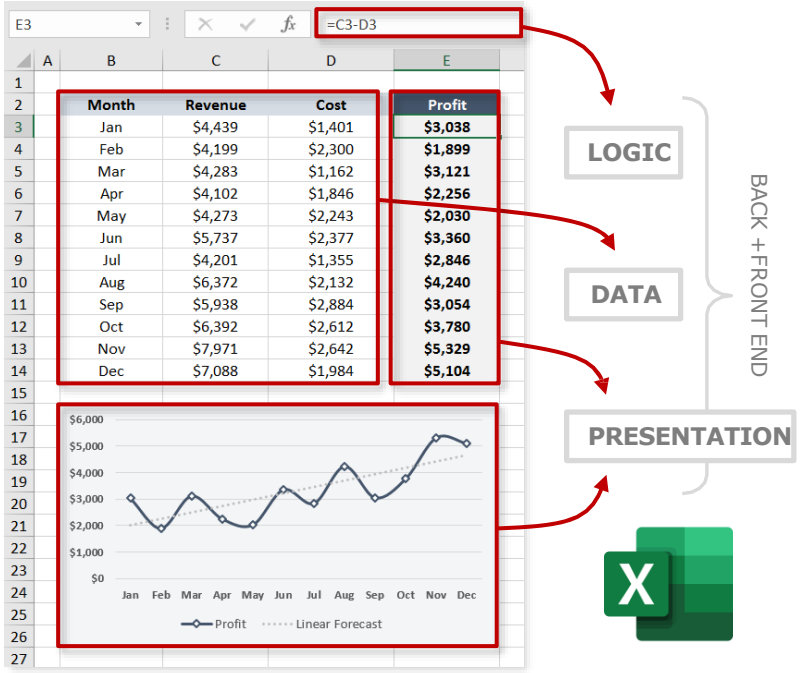


INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

By definition, Excel is a **full-stack development** platform*; but rather than separating each layer of the process *(data, logic & presentation)*, Excel mixes them all within the same user interface:



VS



INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

*This is NOT a claim that Excel is always the ***right*** full-stack dev tool (or, in may cases, even a viable one). Rather, it's an effort to inspire users to think creatively about what Excel can do

CONDITIONAL STATEMENTS

All Conditional Statements in Excel are based on simple "IF/THEN" statements:

- *IF it's raining, **THEN** bring an umbrella*
- *IF it's sunny, **THEN** bring sunglasses*
- *IF it's sunny **AND** it's summer, skip work and go to the beach*

You're basically saying *"Hey Excel, if this statement is true, do this. Otherwise, do something else."*

=IF(logical_test, [Value if True], [Value if False])

Any test that results in either **TRUE** or **FALSE**

(*i.e. A1="Google", B2<100, etc*)

Value returned if logical test is **TRUE**

Value returned if logical test is **FALSE**

	A	B	C	D
1	Location	Temp (F)	Precip (mm)	Freeze
2	A	75	0	No
3	B	18	0	Yes
4	C	86	0	No
5	D	80	2.3	No
6	E	28	1.2	Yes
7	F	68	0.5	No
8	G	26	0	Yes

=IF(B2<=32,"Yes","No")

In this case we're categorizing the Freeze column as "Yes" if the temperature is equal to or below 32, otherwise "No"

By using Nested IF Statements, you can include multiple logical tests within a single formula:

	A	B	C	D	E
1	Location	Temp (F)	Precip (mm)	Freeze	Climate
2	A	75	0	No	Mild
3	B	18	0	Yes	Cold
4	C	86	0	No	Hot
5	D	80	2.3	No	Mild
6	E	28	1.2	Yes	Cold
7	F	68	0.5	No	Mild
8	G	26	0	Yes	Cold

=IF(B2<40,"COLD",IF(B2>80,"HOT","MILD"))

If temp<40, climate = "Cold", if temp>80, climate = "Hot", otherwise climate = "Mild"

Excel's AND and OR statements allow you to include multiple logical tests at once:

	A	B	C	D	E	F	G
1	Location	Temp (F)	Precip (mm)	Freeze	Climate	Precip Type	Conditions
2	A	75	0	No	Mild	None	Dry
3	B	18	0	Yes	Cold	None	Dry
4	C	86	0	No	Hot	None	Dry
5	D	80	2.3	No	Mild	Rain	Wet
6	E	28	1.2	Yes	Cold	Snow	Wet
7	F	68	0.5	No	Mild	Rain	Wet
8	G	26	0	Yes	Cold	None	Dry

=IF(OR(F2="Rain",F2="Snow"),"Wet","Dry")

Here we're categorizing conditions as "Wet" if the precipitation type equals "rain" OR "snow", otherwise Conditions = "Dry"

=IF(AND(D2="Yes",C2>0),"Snow",IF(AND(D2="No",C2>0),"Rain","None"))

If the temp is below freezing AND the amount of precipitation >0, then Precip Type = "Snow", if the temp is above freezing AND the amount of precipitation >0, then Precip Type = "Rain", otherwise Precip Type = "None"

PRO TIP:

When writing nested functions, copy/paste repetitive pieces and tweak individual elements to save time (rather than starting from scratch)

If you want to evaluate a case where a logical statement is *not* true, you can use either the NOT statement or a "<>" operator

	A	B	C	D	E	F	G
1	Location	Temp (F)	Precip (mm)	Freeze	Climate	Precip Type	Conditions
2	A	75	0	No	Mild	None	Dry
3	B	18	0	Yes	Cold	None	Dry
4	C	86	0	No	Hot	None	Dry
5	D	80	2.3	No	Mild	Rain	Wet
6	E	28	1.2	Yes	Cold	Snow	Wet
7	F	68	0.5	No	Mild	Rain	Wet
8	G	26	0	Yes	Cold	None	Dry

=IF(NOT(C2=0),"Wet","Dry")

=IF(C2<>0,"Wet","Dry")

In both of these examples, we're defining Conditions = "Wet" if the amount of precipitation is NOT equal to 0

The IFERROR statement is an excellent tool to eliminate annoying error messages *(#N/A, #DIV/0!, #REF!, etc.)*, which is particularly useful for front-end formatting

=IFERROR(value, value_if_error)

Formula or value that may or may not result in an error

Value returned in the case of an error

PRO TIP:

If you're writing a formula that may trigger an error (i.e. a VLOOKUP where not all values have a match), WRITE THE FULL FORMULA FIRST then wrap it in an IFERROR statement

Excel offers a number of different IS formulas, each of which checks whether a certain condition is true:

ISBLANK = *Checks whether the reference cell or value is blank*

ISNUMBER = *Checks whether the reference cell or value is numerical*

ISTEXT = *Checks whether the reference cell or value is a text string*

ISERROR = *Checks whether the reference cell or value returns an error*

ISEVEN = *Checks whether the reference cell or value is even*

ISODD = *Checks whether the reference cell or value is odd*

ISLOGICAL = *Checks whether the reference cell or value is a logical operator*

ISFORMULA = *Checks whether the reference cell or value is a formula*

COMMON STATS FUNCTIONS

The Count, Average, Median, Mode, Max/Min, Percentile and Standard Deviation/Variance functions are used to perform basic calculations on a data array

	A	B	C	D	
1	Value				
2	90		Sample Size	19	=COUNT(A2:A20)
3	13				
4	22		Average:	51.47	=AVERAGE(A2:A20)
5	98				
6	61		Median:	54	=MEDIAN(A2:A20)
7	68				
8	50		Mode:	22	=MODE(A2:A20)
9	91				
10	16		Max:	98	=MAX(A2:A20)
11	23				
12	60		Min:	13	=MIN(A2:A20)
13	22				
14	56		25th Percentile	23	=PERCENTILE(A2:A20,.25)
15	54				
16	87		75th Percentile	68	=PERCENTILE(A2:A20,.75)
17	33				
18	68		Standard Deviation	28	=STDEV(A2:A20)
19	45				
20	21		Variance	767	=VAR(A2:A20)

	A
1	Value
2	90
3	13
4	22
5	98
6	61
7	68
8	50

RANK(A2,A2:A8) =2

RANK(A3,A2:A8) =7 *(lowest)*

RANK(A4,A2:A8) =6

RANK(A5,A2:A8) =1 *(highest)*

RANK(A6,A2:A8) =4

RANK(A7,A2:A8) =3

RANK(A8,A2:A8) =5

The RANK function returns the rank of a particular number among a list of values

The SMALL/LARGE functions return the nth smallest/largest values within an array

	A
1	Value
2	90
3	13
4	22
5	98
6	61
7	68
8	50

LARGE(A2:A8,2) = 90

(the 2nd largest number in the array is 90)

SMALL(A2:A8,3) = 50

(the 3rd smallest number in the array is 50)

	A	B
1	Value	Percent Rank
2	2,717	18%
3	3,485	24%
4	5,202	76%
5	3,612	29%
6	4,432	59%
7	2,699	12%
8	4,585	65%
9	6,003	94%
10	4,820	71%
11	2,550	6%
12	5,795	88%
13	4,240	41%
14	6,827	100%
15	4,359	53%
16	2,320	0%
17	5,775	82%
18	4,241	47%
19	3,966	35%

PERCENTRANK returns the rank of a value as a percentage of a given array or dataset

=PERCENTRANK(array, x)

What range of data are you looking at?

Which **value** within the range are you looking at?

PERCENTRANK($A$2:$A$19, A14) = 100% ***(highest)***

PERCENTRANK($A$2:$A$19, A16) = 0% ***(lowest)***

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

RAND() and RANDBETWEEN act like random number generators in Excel:

	A	B	C	D	E
1	0.5173	0.4091	0.7560	0.9012	0.2167
2	0.0906	0.2317	0.0906	0.5856	0.8646
3	0.1544	0.8240	0.4279	0.8782	0.7795
4	0.0097	0.0872	0.7740	0.9137	0.7815
5	0.2089	0.7028	0.0449	0.8173	0.9983
6	0.0761	0.4388	0.4056	0.5639	0.0668

The RAND() function returns a random value between 0 and 1 (to 15 digits)

The RANDBETWEEN function returns an integer between two values that you specify

	A	B	C	D	E
1	83	23	64	62	92
2	59	45	40	50	91
3	24	37	70	30	32
4	54	85	69	55	3
5	73	12	36	53	2
6	29	72	68	59	99

=RANDBETWEEN(0,100)

The SUMPRODUCT formula multiplies corresponding cells from multiple arrays and returns the sum of the products (*Note: all arrays must have the same dimensions*)

=SUMPRODUCT(array1, array2 … array_N)

Example: *Total Revenue*

	A	B	C	D
1	Product	Quantity	Price	Revenue
2	Apple	2	$0.50	$1.00
3	Banana	4	$1.00	$4.00
4	Orange	3	$0.80	$2.40
5	Total			$7.40

	A	B	C	D
1	Product	Quantity	Price	Revenue
2	Apple	2	$0.50	
3	Banana	4	$1.00	
4	Orange	3	$0.80	
5	Total			$7.40

Without using SUMPRODUCT, you could multiply quantity*price in each row and sum the products

SUMPRODUCT(B2:B4,C2:C4) = $7.40

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

SUMPRODUCT is often used with filters to calculate products *only* for rows that meet certain criteria:

	A	B	C	D
1	Store	Product	Quantity	Price
2	Stop & Shop	Apple	2	$0.50
3	Shaws	Banana	4	$1.00
4	Market Basket	Banana	3	$1.00
5	Trader Joe's	Pineapple	8	$2.50
6	Stop & Shop	Orange	2	$0.80
7	Shaws	Apple	1	$0.50
8	Market Basket	Apple	5	$0.50
9	Trader Joe's	Banana	6	$1.00
10	Market Basket	Pineapple	3	$2.50
11	Trader Joe's	Orange	8	$0.80
12	Stop & Shop	Pineapple	3	$2.50
13	Shaws	Pineapple	5	$2.50
14	Stop & Shop	Banana	2	$1.00
15	Shaws	Orange	6	$0.80
16	Market Basket	Orange	7	$0.80
17	Trader Joe's	Apple	3	$0.50

Quantity of goods sold at Shaws:

SUMPRODUCT((A2:A17="Shaws")*C2:C17) = 16

Total revenue from Shaws:

SUMPRODUCT((A2:A17="Shaws")*C2:C17*D2:D17) = $21.80

Revenue from apples sold at Shaws:

SUMPRODUCT((A2:A17="Shaws")*(B2:B17="Apple")*C2:C17*D2:D17) = $0.50

PRO TIP:

When you add filters to a SUMPRODUCT, you need to change the commas to multiplication signs

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

Great, but how does it *really* work?

SUMPRODUCT((A2:A17="Shaws")*(B2:B17="Apple")*C2:C17*D2:D17) = $0.50

	A	B	C	D
1	Store	Product	Quantity	Price
2	Stop & Shop	Apple	2	$0.50
3	Shaws	Banana	4	$1.00
4	Market Basket	Banana	3	$1.00
5	Trader Joe's	Pineapple	8	$2.50
6	Stop & Shop	Orange	2	$0.80
7	Shaws	Apple	1	$0.50
8	Market Basket	Apple	5	$0.50
9	Trader Joe's	Banana	6	$1.00
10	Market Basket	Pineapple	3	$2.50
11	Trader Joe's	Orange	8	$0.80
12	Stop & Shop	Pineapple	3	$2.50
13	Shaws	Pineapple	5	$2.50
14	Stop & Shop	Banana	2	$1.00
15	Shaws	Orange	6	$0.80
16	Market Basket	Orange	7	$0.80
17	Trader Joe's	Apple	3	$0.50

What YOU see

What EXCEL sees

*When you apply a condition or filter to a column, Excel translates those cells as **0**'s (if false) and **1**'s (if true)*

If you multiply all four columns,
ONLY ROWS THAT SATISFY ALL CONDITIONS WILL PRODUCE A NON-ZERO SUM

	A	B	C	D
1	Store	Product	Quantity	Price
2	0	1	2	$0.50
3	1	0	4	$1.00
4	0	0	3	$1.00
5	0	0	8	$2.50
6	0	0	2	$0.80
7	1	1	1	$0.50
8	0	1	5	$0.50
9	0	0	6	$1.00
10	0	0	3	$2.50
11	0	0	8	$0.80
12	0	0	3	$2.50
13	1	0	5	$2.50
14	0	0	2	$1.00
15	1	0	6	$0.80
16	0	0	7	$0.80
17	0	1	3	$0.50

The COUNTIF, SUMIF, and AVERAGEIF formulas calculate a sum, count, or average based on specific criteria

	A	B
1	Name	Age
2	George	90
3	Maria	13
4	Ryan	22
5	Tim	98
6	George	61
7	Tim	68
8	Tim	50
9	Maria	91
10	George	16
11	Maria	23
12	Tim	60
13	Ryan	22
14	Maria	56
15	George	54
16	George	87
17	Ryan	33
18	Ryan	68
19	Ryan	45
20	George	21

=COUNTIF(range, criteria)

=SUMIF(range, criteria, sum_range)

=AVERAGEIF(range, criteria, average_range)

Which cells need to match your criteria?

Under what condition do I want to sum, count, or average?

Where are the values that I want to sum or average?

COUNTIF(B2:B20,22) = 2

SUMIF(A2:A20,"Ryan",B2:B20) = 190

SUMIF(A2:A20,"<>Tim",B2:B20) = 702

AVERAGEIF(A2:A20,"Maria",B2:B20) = 45.75

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

COUNTIFS, SUMIFS, and AVERAGEIFS are used when you want to evaluate a count, sum, or average based on *multiple* conditions or criteria

=COUNTIFS(criteria_range1, criteria1, criteria_range2 , criteria2…)

=SUMIFS(sum_range, criteria_range1, criteria1, criteria_range2 , criteria2…)

=AVERAGEIFS(average_range, criteria_range1, criteria1, criteria_range2 , criteria2…)

	A	B	C	D
1	Month	Tactic	Campaign	Clicks
2	Jan	Search	Google	166
3	Jan	Search	MSN	263
4	Jan	Display	Contextual	289
5	Jan	Display	Retargeting	137
6	Feb	Search	Google	124
7	Feb	Search	MSN	311
8	Feb	Display	Contextual	350
9	Feb	Display	Retargeting	384
10	Mar	Search	Google	168
11	Mar	Search	MSN	358
12	Mar	Display	Contextual	347
13	Mar	Display	Retargeting	390

COUNTIFS(B2:B13,"Search", D2:D13,">200") = 3

SUMIFS(D2:D13, A2:A13,"Feb",B2:B13,"Display") = 734

AVERAGEIFS(D2:D13, A2:A13,"Jan",C2:C13,"MSN") = 263

PRO TIP:

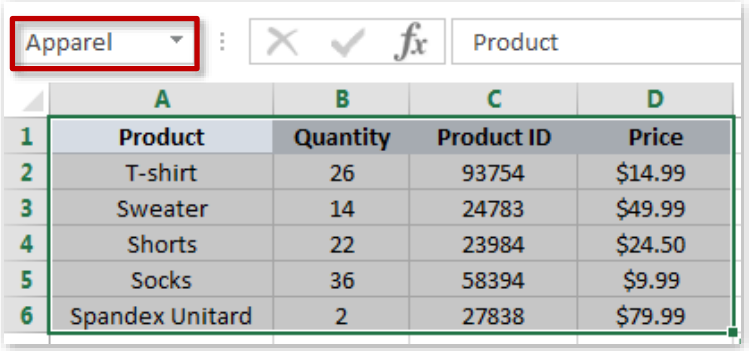
If you use <or >, you need to add quotation marks as you would with text (i.e. ">200")

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

LOOKUP & REFERENCE FUNCTIONS

Using Named Arrays can simplify a lookup function if you use the same data array in multiple formulas

For example, if you name the array from A1:D6 "Apparel"…



	A	B	C	D
1	Product	Quantity	Product ID	Price
2	T-shirt	26	93754	$14.99
3	Sweater	14	24783	$49.99
4	Shorts	22	23984	$24.50
5	Socks	36	58394	$9.99
6	Spandex Unitard	2	27838	$79.99

…you can write your vlookup formula in either of the following ways:

=VLOOKUP(A1,$A$1:$D$6,2)
=VLOOKUP(A1,Apparel,2)

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

Let's take a look at one of Excel's most common reference functions – VLOOKUP:

=VLOOKUP(lookup_value, table_array, col_index_num, [range_lookup])

- **lookup_value**: This is the **value** that you are trying to match in the table array
- **table_array**: This is **where** you are looking for the lookup value
- **col_index_num**: **Which column** contains the data you're looking for?
- **[range_lookup]**: Are you trying to match the **exact** lookup value (0), or something similar (1)?

	A	B	C	D
1	Product	Quantity	Product ID	Price
2	T-shirt	26	93754	$14.99
3	Sweater	14	24783	$49.99
4	Shorts	22	23984	$24.50
5	Socks	36	58394	$9.99
6	Spandex Unitard	2	27838	$79.99

D2=VLOOKUP(A2, $G$1:$H$5, 2, 0)

G	H
Product	Price
Shorts	$24.50
Sweater	$49.99
Spandex Unitard	$79.99
T-shirt	$14.99
Socks	$9.99

To populate the Price in column D, we look up the name of the product in the data array from G1:H5 and return the value from the 2nd column over

Use HLOOKUP if your table array is transposed (variables headers listed in rows)

=HLOOKUP(lookup_value, table_array, row_index_num, [range_lookup])

- **lookup_value**: This is the **value** that you are trying to match in the table array
- **table_array**: This is **where** you are looking for the lookup value
- **row_index_num**: **Which row** contains the data you're looking for?
- **[range_lookup]**: Are you trying to match the **exact** lookup value (0), or something similar (1)?

	A	B	C	D
1	Product	Quantity	Product ID	Price
2	T-shirt	26	93754	$14.99
3	Sweater	14	24783	$49.99
4	Shorts	22	23984	$24.50
5	Socks	36	58394	$9.99
6	Spandex Unitard	2	27838	$79.99

D2=HLOOKUP(A2, $H$1:$L$2, 2, 0)

With an HLOOKUP, we search for the product name in F1:J2 and return the value from the 2nd row down

	G	H	I	J	K	L
	Product	Shorts	T-shirt	Sweater	Spandex Unitard	Socks
	Price	$24.50	$14.99	$49.99	$79.99	$9.99

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

There are two key rules that constrain VLOOKUP and HLOOKUP formulas:

1. The lookup value must be in the first column of a VLOOKUP table array or the first row of a HLOOKUP table array

2. Excel will always return the value from the top most row or left most column of a table array when multiple instances of the lookup value are present

PRO TIP:

Avoid breaking Law #2 by identifying a "Key" that is common to both datasets and is unique for every row (NOTE: Keys often take the form of a concatenation of multiple fields)

The ROW function returns the row number of a given *reference*, while the ROWS function returns the number of rows in a given *array* or *array formula*

=ROW([reference])

=ROWS(array)

This example uses an array, which is why it includes the fancy {}signs – more on that in the ARRAY functions section

ROW(C10) = 10

ROWS(A10:D15) = 6

ROWS({1,2,3;4,5,6}) = 2

The **COLUMN** function returns the column number of a given *reference*, while the **COLUMNS** function returns the number of columns in a given *array* or *array formula*

=COLUMN([reference])

=COLUMNS(array)

PRO TIP:

Leave the cell reference out and just write ROW() or COLUMN() to return the row or column number of the cell in which the formula is written

COLUMN(C10) = **3**

COLUMNS(A10:D15) = **4**

COLUMNS({1,2,3;4,5,6}) = **3**

The INDEX function returns the *value* of a specific cell within an array

=INDEX(array, row_num, column_num)

- array: What range of cells are you looking at?
- row_num: How many rows down is the value you want?
- column_num: How many columns over is the value you want?

	A	B	C
1	Tools	Price	Inventory
2	Hammer	$5.00	55
3	Screw Driver	$2.50	66
4	Pliers	$3.34	333
5	Wrench set	$10.00	234
6	Chain Saw	$55.48	23
7	Tool Box	$19.99	5
8	Level	$2.25	7

INDEX($A$1:$C$5, 5, 3) = 234

In this case we're telling Excel to find the value of a cell somewhere within the array of A1:C5. Starting from the upper left, we move down to the 5th row and right to the 3rd column, to return the value of 234

The MATCH function returns the *position* of a specific value within a column or row

=MATCH(lookup_value, lookup_array, [match_type])

What value are you trying to find the position of?

In which row or column are you looking? (**must be a 1-dimensional array**)

Are you looking for the exact value (0), or anything close?

1: *Find largest value* **<** *or* **=** *lookup_value*

0: *Find exact lookup_value*

-1: *Find smallest value* **>** *or* **=** *lookup_value*

	A	B
1	Tools	Price
2	Hammer	$5.00
3	Screw Driver	$2.50
4	Pliers	$3.34
5	Wrench set	$10.00

MATCH("Pliers",$A$1:$A$5, 0) = 4

	A	B	C
1	Tools	Price	Inventory
2	Hammer	$5.00	55
3	Screw Driver	$2.50	66
4	Pliers	$3.34	333

MATCH(66,$A$3:$C$3, 0) = 3

*Matching the word "**Pliers**" in column A, we find it in the **4th row**. Matching the number **66** in row 3, we find it in the **3rd column***

INDEX and MATCH are commonly used in tandem to act like a LOOKUP function; the only difference is that INDEX/MATCH can find values in any column or row in an array

Example: *Price Checker*

	A	B	C	D
1		Small	Medium	Large
2	Sweater	$10	$12	$15
3	Jacket	$30	$35	$40
4	Pants	$25	$30	$35
5				
6	*Product:*	Pants		
8	*Size:*	Medium		
10	**PRICE:**	?		

*In this example, we want to populate the price of a given product and size in cell **B10** by returning a particular value within the array **B2:D4***

B10=INDEX(B2:D4, MATCH(B6,A2:A4,0), MATCH(B8,B1:D1,0))

*The number of rows down to index depends on what **product** I'm looking for, so we use a MATCH function and search for the value in cell **B6** (in this case "Pants")*

*The number of columns over to index depends on what **size** I'm looking for, so we use a MATCH function and search for the value in cell **B8** (in this case, "Medium")*

Considering the output of each MATCH function, the formula is just a simple INDEX:

B10 = INDEX(B2:D4, 3, 2) = $30

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

XLOOKUP can retrieve values from a table or range by matching a lookup value, and offers more flexibility than **VLOOKUP**, **HLOOKUP**, or **INDEX** & **MATCH** formulas

=XLOOKUP(lookup_value, lookup_array, return_array, [if_not_found], [match_mode], [search_mode]**)**

- **lookup_value**: Which **value** are you looking to match?
- **lookup_array**: **Where** are you trying to find a match for your lookup value?
- **return_array**: Where are the **values** you want to retrieve?
- [if_not_found]: What if the lookup value **isn't found** in the lookup array?
- [match_mode]: Are you looking for an **exact**, **approximate**, or **wildcard** match?
- [search_mode]: Do you want to search **top down** or **bottom up**?

IMPORTANT NOTE: XLOOKUP is currently only available for **Office 365** subscribers

XLOOKUP

- Can retrieve a **dynamic array** of results
- Can lookup values **anywhere** in an array (left or right, horizontal or vertical)
- Defaults to **exact match**
- Supports native **wildcard** text matching
- Includes **built-in error handling** when a lookup value is not found
- Can find approximate matches in **unsorted** lists
- Can search **top-down** or **bottom-up**

VLOOKUP

- Can only return a **single value**
- Can only lookup values to the **right**, requires **HLOOKUP** for horizontal matching
- Defaults to **approximate match**
- Does not natively support **wildcard** matching
- Requires an additional **IFERROR** function for error handling
- Requires **sorted** lists for approximate matching
- Only searches **top-down**

The CHOOSE function selects a value, cell reference, or function to perform from a list, based on a given index number

=CHOOSE(index_num, value1, [value2], …)

FUN FACTS ABOUT **CHOOSE:**

- List items can include **numbers**, **cell references**, **defined names**, **formulas**, or **text** *(or a mix!)*
- CHOOSE acts like an **INDIRECT** function, and can interpret cell references instead of treating them as text
- You can combine CHOOSE with other functions, or nest it directly into a cell reference

The OFFSET function is similar to INDEX, but can return either the value of a cell within an array (like INDEX) or a specific *range* of cells

=OFFSET(reference, rows, columns, [height], [width])

- reference: What's your starting point?
- rows: How many rows down should you move?
- columns: How many columns over should you move?
- [height], [width]: If you want to return a multidimensional array, how tall and wide should it be?

An OFFSET formula where [height]=1 and [width]=1 will operate exactly like an INDEX. A more common use of OFFSET is to create dynamic arrays (like the Scroll Chart example in the appendix)

PRO TIP:

Don't use OFFSET or INDEX/MATCH when a simple VLOOKUP will do the trick

TEXT FUNCTIONS

Text functions can be used to standardize formatting, particularly the TRIM, UPPER, LOWER, and PROPER functions:

	A	B	C	D
1	**Sample Text String**	**Formula**	**Output**	**Notes**
2	SAMPLE sentence	**=TRIM(A2)**	**SAMPLE sentence**	*Removes any leading or trailing spaces from a text string*
3	SAMPLE sentence	**=LOWER(A3)**	**sample sentence**	*Converts all characters in a text string to lower case*
4	SAMPLE sentence	**=UPPER(A4)**	**SAMPLE SENTENCE**	*Converts all characters in a text string to upper case*
5	SAMPLE sentence	**=PROPER(A5)**	**Sample Sentence**	*Converts all characters in a text string to proper case (first letter capitalized)*
6				

PRO TIP:

If two text strings are identical except one has a trailing space, they will look exactly the same but Excel will treat them as completely different values; TRIM will make them equivalent

CONCATENATE allows you to combine text, cell values, or formula outputs into a single text string

Note: Rather than typing "**=CONCATENATE**(*Text1, Text2…*)", you can simply separate each piece of the resulting text string with an ampersand ("**&**")

	A	B	C	D
1	First Name	Last Name	Formula	Output
2	Daniel	Wright	=A2&B2	DanielWright
3	Daniel	Wright	=A3&" "&B3	Daniel Wright
4	Daniel	Wright	=LEFT(A4,3)&" "&B4	Dan Wright
5	Daniel	Wright	=LEFT(A5,3)&" "&LEFT(B5,1)&"."	Dan W.

The LEFT, MID, and RIGHT functions return a specific number of characters from a location within a text string, and LEN returns the total number of characters

=LEFT(text, [num_chars])
=RIGHT(text, [num_chars])
=MID(text, start_num, num_chars)

	A	B	C	D
1	**Sample Text String**	**Formula**	**Output**	**Notes**
3	MA-02215%AAA%_100	**=LEFT(A3,2)**	**MA**	*Returns 2 characters, starting from the left*
5	MA-02215%AAA%_100	**=MID(A5,4,5)**	**02215**	*Returns 5 characters from the middle of the string, starting with position 4*
7	MA-02215%AAA%_100	**=RIGHT(A7,3)**	**100**	*Returns 3 characters, starting from the right*
9	MA-02215%AAA%_100	**=LEN(A9)**	**17**	*Returns the length of the string (=17 characters)*

The TEXT function converts a numeric value to text and assigns a particular format

=TEXT(value, format_text)

Numeric value, formula that evaluates to a numeric value, or reference to a cell containing a numeric value

Numeric format as a text string enclosed in quotes (i.e. "**m/d/yyyy**", "**$0.00**" or "**#,##0.00**"

	A	B
1	**Name**	**Earnings**
2	Tim	$4,500
3	George	$3,250
4	Lisa	$3,725

="Lisa earned "&B4 *returns* **"Lisa earned 3725"**

="Lisa earned "&TEXT(B4,"$#,###") *returns* "Lisa earned $3,725"

PRO TIP:

Use VALUE to convert a text string that represents a number into a value

The SEARCH function returns the number of the character at which a specific character or text string is first found (otherwise returns #VALUE! error)

=SEARCH(find_text, within_text, [start_num])

What character or string are you searching for?

Where is the text that you're searching through?

Search from the beginning (default) or after a certain number of characters?

	A	B	C	D
11	MA-02215%AAA%_100	=SEARCH("%",A11)	9	*Searches the string for "%" and returns the position*
13	MA-02215%AAA%_100	=SEARCH("%",A13,10)	13	*Searches for "%", starting with the 10th character, and returns the position*
15	MA-02215%AAA%_100	=MID(A15,SEARCH("%",A15),5)	%AAA%	*Returns 5 chars from the middle of the string, beginning where it finds the "%"*
17	MA-02215%AAA%_100	=MID(A17,SEARCH("%",A17)+1,3)	AAA	*Returns 3 characters from the middle of the string, beginning 1 position after "%"*

PRO TIP:

The FIND function works exactly the same way, but is case-sensitive

IF(ISNUMBER(SEARCH is powerful combination of functions that can be used to classify data based on cells that contain specific strings of text

=IF(ISNUMBER(SEARCH(find_text, within_text)),value_if_true, value_if_false)

Searches for a specific string of text within a given cell

Returns one value if that string is found (TRUE), and another if it is not found (FALSE)

	A	B
1	**Placement**	**Media**
2	12983-Aff-160x90_small	Other
3	982308-Disp-160x90_large	Display
4	23124-Aff-160x90_small	Other
5	463-Disp-160x90_small	Display
6	390238-Agg-160x90_large	Other

=IF(ISNUMBER(SEARCH("Disp",A2)),"Display","Other")

Search the cells in column A for the text string "Disp" and classify column B as "Display" if you find it, "Other" if you don't

DATE & TIME FUNCTIONS

Every date in Excel has an associated date value, which is how Excel calculates the passage of time (using midnight on 1/1/1900 as the starting point)

Excel recognizes most typed dates and automatically applies a common format (i.e. m/d/yyyy), along with an associated date value (cell format → General)

Note: *If you type a date in a format that Excel does NOT recognize, it will be treated as text and there will be no associated date value; however, you can use a* ***DATEVALUE*** *or* ***TIMEVALUE*** *function to convert unformatted dates or times into serial values*

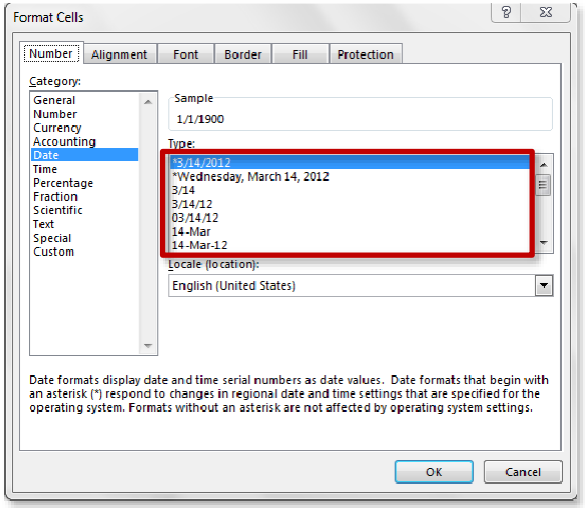
Date	Date Value
1/1/1900	1
1/11/1900	11
2/6/2015	42041
2/6/15 12:00 PM	42041.5
2/6/15 6:00 PM	42041.75

Jan 1,1900 is the first date with an assigned date value (1). Feb 6, 2015 is the 42,041st day since 1/1/1900, so its date value =42041

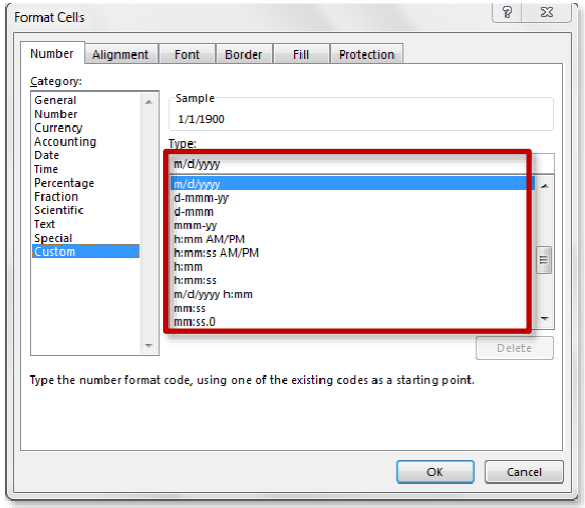
Date values can also indicate fractions of days: 42041.5 translates to noon on 2/6/2015 (50% through the day), and 42041.75 translates to 6:00pm on 2/6/2015 (75% through the day)

To format dates in Excel, you can either select a preset option from the "Date" category of the "Format Cells" dialog box, OR create your own custom format

Preset Formats:



Custom Format:

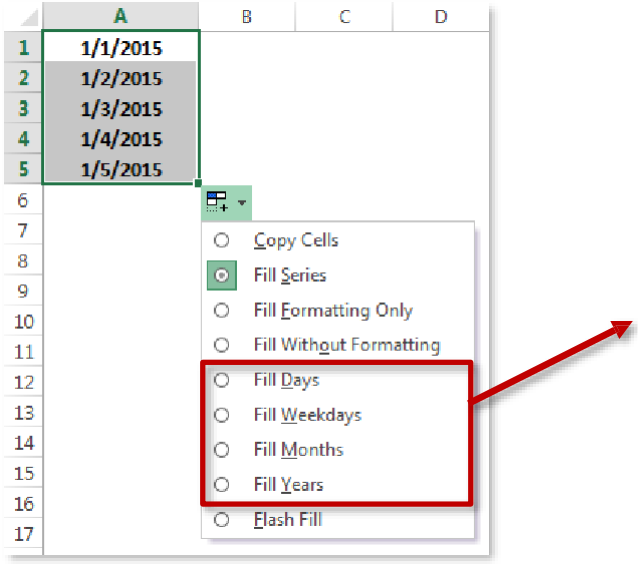


You can build your own custom formats using combinations of date/time codes. For example:

d = *day w/out leading zero (1-31)*
dd = *day w/ leading zero (01-31)*
ddd = *day-of-week (Sat)*
dddd = *day-of-week (Saturday)*
m = *month w/out leading zero (1-15)*
mm = *month w/ leading zero (01-15)*
mmm = *month abbreviation (Jan)*
mmmm = *full month (January)*
yy = *last 2 digits of year (15)*
yyyy = *full year (2015)*

(full list available at support.office.com)

When you drag the corner of a cell containing a date, Excel automatically applies subsequent values automatically using Fill Series options:



*Click the **Auto Fill Options** button to determine exactly which values your subsequent cells should take:*

Copy Cells = Repeats the same value in all cells

Fill Days = Increases the date by 1 day per cell

Fill Weekdays = Increases the date by 1 day per cell (excluding weekends)

Fill Months = Increases the date by 1 month per cell

Fill Years = Increases the date by 1 year per cell

The TODAY() and NOW() functions return the current date or exact time

Note: *These are* ***volatile*** *functions, meaning that they change with every worksheet calculation*

TODAY()=	2/6/2015
NOW()=	2/6/2015 17:15

This is what the ***TODAY()*** *and* ***NOW()*** *functions return at 5:15pm on February 6, 2015. Note that these values will automatically update with every change made to the workbook*

PRO TIP:

Make sure to enter TODAY() and NOW() functions with both parentheses included – these functions don't refer to other cells

Excel will always calculate dates and times based on their *precise* underlying serial values, but what if you need to work with less-specific values, like months instead of days, or hours instead of seconds?

The YEAR, MONTH, DAY, HOUR, MINUTE, and SECOND functions extract individual components of a given date:

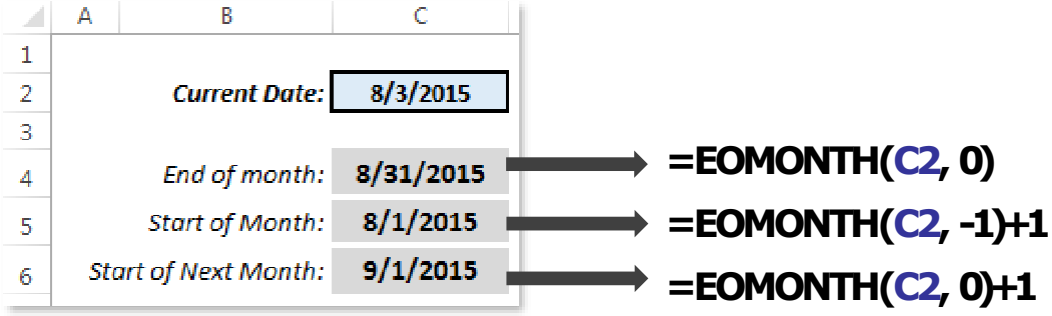
	A	B	C	D	E	F	G
1		YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
2	2/6/2015 17:57	2015	2	6	17	57	16
3		=YEAR(A2)	=MONTH(A2)	=DAY(A2)	=HOUR(A2)	=MINUTE(A2)	=SECOND(A2)
4							

Use the EOMONTH function to calculate the last day of a given month, or to calculate the start/end dates of previous or future months

=EOMONTH(start_date, months)

Reference to the cell containing the start/current date

Number of months before or after the start/current date (positive number yields a date in the future, negative number yields a date in the past



YEARFRAC calculates the fraction of a year represented by the number of whole days between two dates

=YEARFRAC(start_date, end_date, [basis])

Reference to the cell containing the start date

Reference to the cell containing the end date

Option specify the type of day count to use:

- **0 (default)** = *US (NASD) 30/360*
- **1** = *actual/actual* ***(RECOMMENDED)***
- **2** = *actual/360*
- **3** = *actual/365*
- **4** = *European 30/360*

	A	B
1		
2	*Start Date:*	1/1/2015
3	*End Date:*	2/28/2015

=YEARFRAC(B2, B3, 1) = 15.9%

=YEARFRAC(B2, B3, 2) = 16.1%

PRO TIP:

YEARFRAC is a great tool for pacing and projection calculations

If you want to know which day of the week a given date falls on, there are two ways to do it:

1) Use a custom cell format of either "ddd" (Sat) or "dddd" (Saturday)

*-Note that this doesn't change the underlying **value**, only how that value is displayed*

2) Use the **WEEKDAY** function to return a serial value corresponding to a particular day of the week (either 1-7 or 0-6)

=WEEKDAY(serial_number, [return type])

This refers to a cell containing a **date** or **time**

0 (default) = Sunday (1) to Saturday (7)

1 = Monday (1) to Sunday (7)

3 = Monday (0) to Sunday (6)

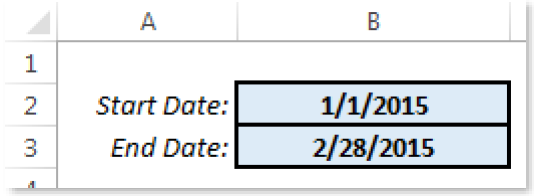
WORKDAY returns a date that is a specified number of days before or after a given start date, excluding weekends and (optionally) holidays; NETWORKDAYS counts the number of workdays between two dates:

=WORKDAY(start_date, days, [holidays])

- This refers to the cell containing the start date
- Number of days before or after start date
- Optional reference to a list of holiday dates

=NETWORKDAYS(start_date, end_date, [holidays])

- This refers to the cell containing the start date
- This refers to the cell containing the end date
- Optional reference to a list of holiday dates



	A	B
1		
2	*Start Date:*	1/1/2015
3	*End Date:*	2/28/2015

=WORKDAY(B2, 20) = 1/29/2015

=NETWORKDAYS(B2, B3) = 42

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

DATEDIF calculates the number of days, months, or years between two dates

=DATEDIF(start_date, end_date, unit)

- **start_date** — Reference to the cell containing the start date
- **end_date** — Reference to the cell containing the end date
- **unit** — How do you want to calculate the difference?
  - **"D"** = *#of days between dates*
  - **"M"** = *#of months between dates*
  - **"Y"** = *#of years between dates*
  - **"MD"** = *#of days between dates, ignoring months and years*
  - **"YD"** = *#of days between dates, ignoring years*
  - **"YM"** = *#of months between dates, ignoring days and years*

	A	B
1		
2	*Start Date:*	1/1/2015
3	*End Date:*	2/28/2015

=DATEDIF(B2, B3, "D") = 58

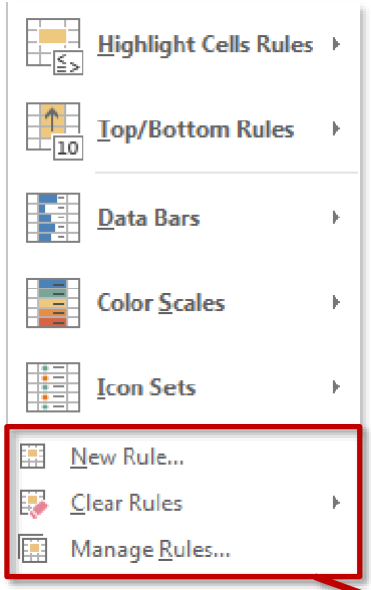
=DATEDIF(B2, B3, "MD") = 27

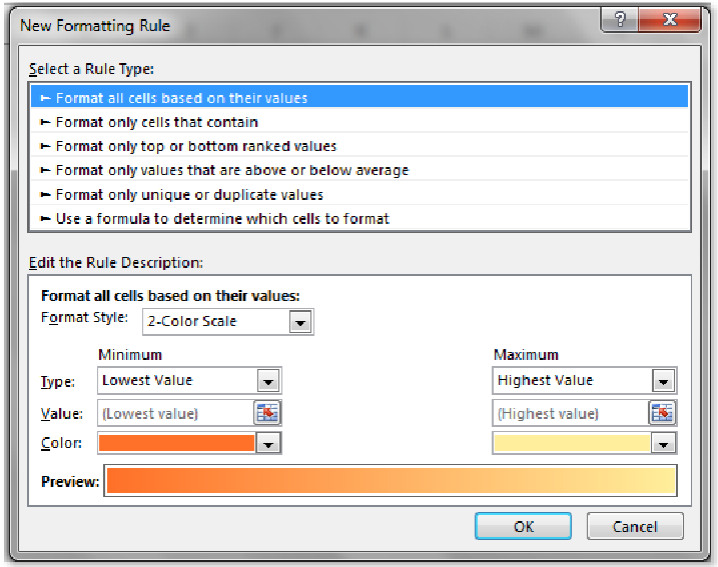
PRO TIP:

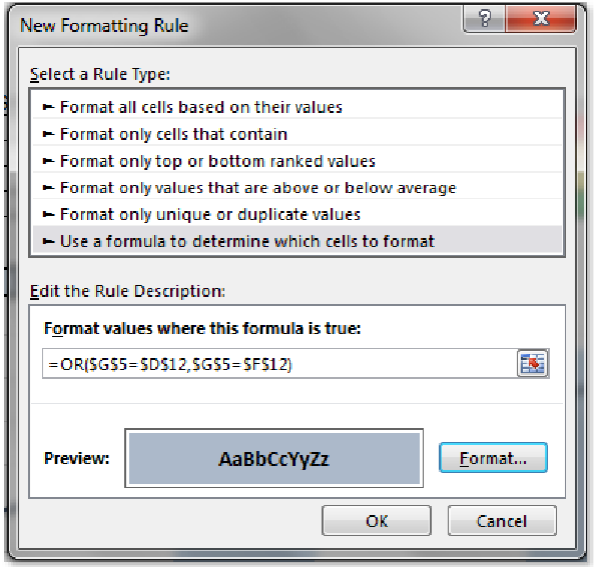
If you only need to calculate the #of days between dates, just use subtraction

FORMULA-BASED FORMATS

If you want to go rogue, you can adjust the style of existing conditional formats or create your own formula-based rules







This is where you can add, clear, and manage your conditional formatting rules

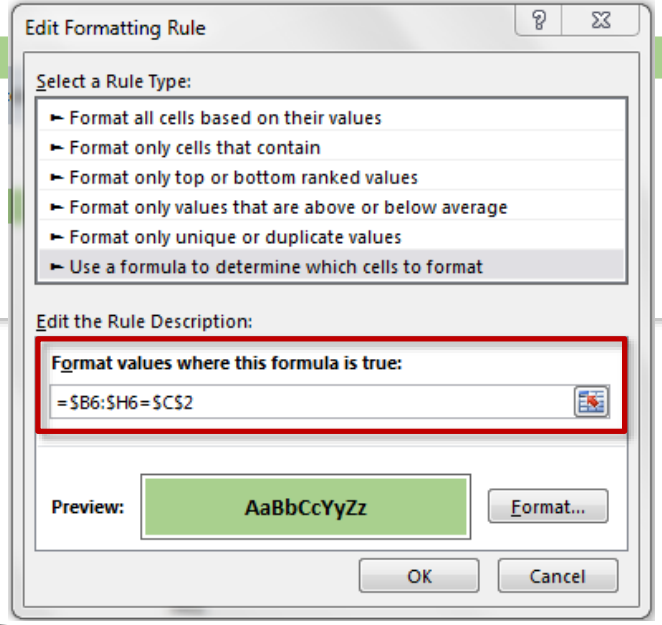
INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

Formula-Based Formatting

State: Arizona

Arizona
Arkansas
California
Colorado
Connecticut
D.C.
Delaware
Florida

State		Population	Student Pop.	SAT Participation Rate	Mean Verbal Score	Mean Math Score
Alabama		4447100	177884	9%	559	554
Alaska		626932	12539	51%		
Arizona	**2001**	**5130632**	**102613**	**34%**		
Arkansas	2001	2673400	53468	6%		
California	2001	33871648	1016149	51%		
Colorado	2001	4301261	172050	31%		
Connecticut	2001	3405565	102167	82%		
D.C.	2001	783600	23508	56%		
Delaware	2001	572059	17162	67%		



In this example we're formatting the cells in columns B through H with a green fill and bold text, but only when the state name is equal to the value in cell $C$2

Note that the row label is relative (no "$"), which allows us to apply this formatting to other rows without losing functionality

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

ARRAY FORMULAS

Array functions perform multiple calculations on one or more items in an array, and can take the form of either a *single-cell* formula (which exists within one cell) or a *multi-cell* formula (which can be applied to a number of cells and return multiple results)

You must press **CTRL-SHIFT-ENTER** to enter, edit, or delete an array formula; this automatically adds brackets "{ }" to indicate that the function applies to an array

	A	B	C	D
1	Name	Earnings	Units	
2	Tim	$4,500	4	$18,000
3	George	$3,250	2	
4	Lisa	$3,725	3	
5	Zach	$4,150	5	

*If you select **D2:D5**, type "**=B2:B5*C2:C5**" and hit ENTER, the formula will only be applied to cell **D2***

	A	B	C	D
1	Name	Earnings	Units	
2	Tim	$4,500	4	$18,000
3	George	$3,250	2	$6,500
4	Lisa	$3,725	3	$11,175
5	Zach	$4,150	5	$20,750

*If you select **D2:D5**, type "**=B2:B5 * C2:C5**" and hit CTRL-SHIFT-ENTER, you have created an array formula applied to all cells in the range*

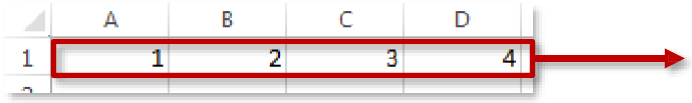
When you work with **array functions**, you must obey the following rules:

1. You *must* press **CTRL-SHIFT-ENTER (C-S-E)** to edit or enter an array formula
2. For multi-cell array functions, you must select the range of cells *before* entering the formula
3. You cannot change the contents of any individual cell which is part an array formula
4. You can move or delete an *entire* array formula, but not a piece of it (so you often have to delete and rebuild)
5. You cannot insert blank cells into or delete cells from a multi-cell array formula

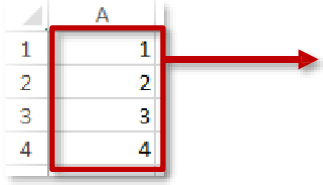
Array functions can be incredibly powerful, but also a total buzzkill to work with; here are some of the key pros and cons of using them:

PROS	CONS
-Condenses multiple calculations into one formula, often reducing file size	-Can be very difficult to modify or delete existing array formulas
-Can perform some complex functions that non-array formulas cannot	-Limited visibility into the formula's function, especially for users who are not familiar with arrays
-Reduces the risk of human error such as accidentally deleting parts of arrays or mistyping formulas	-Eliminates the option to modify cells contained within arrays
	-May reduce processing speed if multiple array functions are used

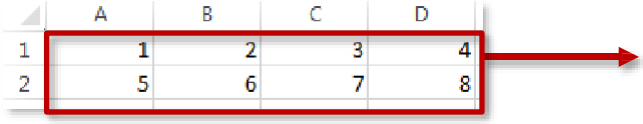
Array constants are created by manually entering a list of items directly into the formula bar and manually surrounding the list with brackets ({ })



***Horizontal* array constants** create an array contained within a single row, and are delimited by commas (i.e. Select A1:D1, type "**={1,2,3,4}**" then hit C-S-E)

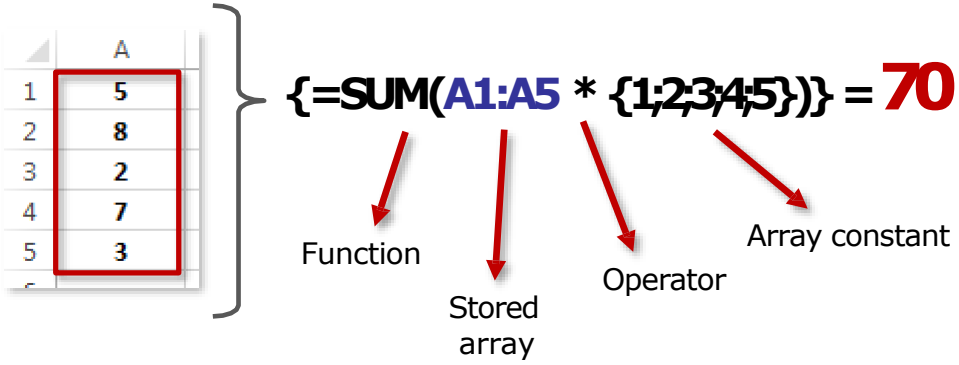


***Vertical* array constants** create an array contained within a single column, and are delimited by semicolons (i.e. Select A1:A4, type "**={1;2;3;4}**" then hit C-S-E)



***Two-dimensional* array constants** create an array contained across multiple rows and columns (i.e. Select A1:D2, type "**={1,2,3,4;5,6,7,8}**" then hit C-S-E)

Array constants can contain values, text (surrounded by " "), logical values (TRUE, FALSE), or error values (#N/A), and can be used as part of an array formula

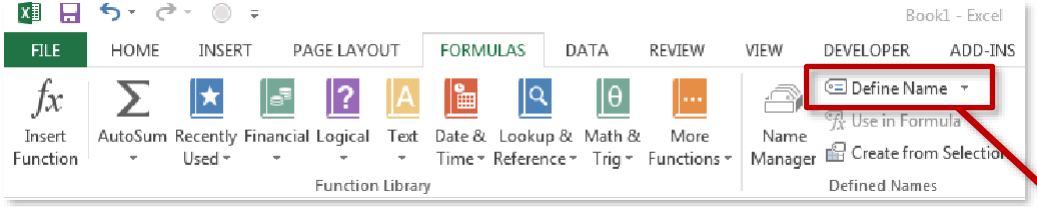


*This function takes each value in the array **A1:A5** and multiplies it against the corresponding value in the array constant **{1;2;3;4;5}**, which essentially translates into the following formula: **=SUM(A1*1, A2*2, A3*3, A4*4, A5*5)***

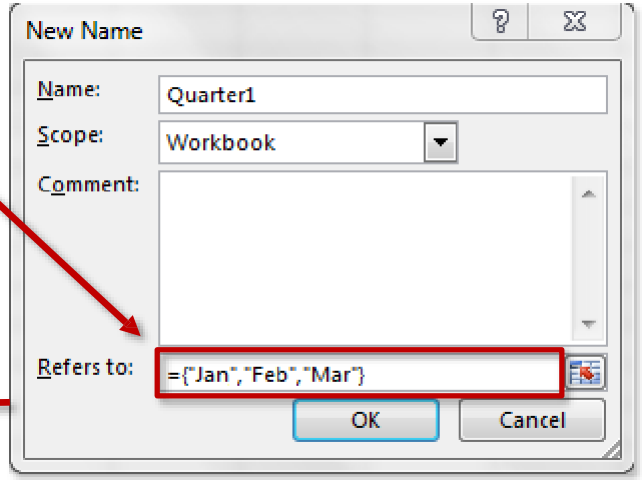
PRO TIP:

You manually add the brackets when you type array constants, but the additional brackets surrounding the entire formula are automatically added once you press C-S-E

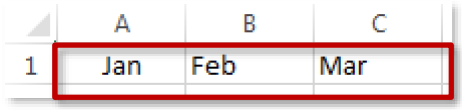
Just like normal cell ranges, array constants can be assigned a name using Excel's name manager, which can make them much easier to work with



*Select "Define Name" (or Name Manager → New) from the **Formulas** tab*



*In the **New Name** dialog box, enter the array constant (remembering to manually include the brackets), give it a name, and select OK*

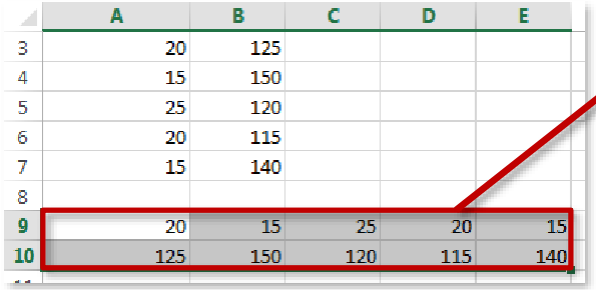


*Now if you select **A1:C1**, type "**=Quarter1**" and press CTRL-SHIFT-ENTER, the saved array will populate*

The TRANSPOSE function allows you to change the orientation of a given data array *(i.e. from 5 rows x 2 columns to 2 rows x 5 columns)*

NOTE: The range in which you enter a TRANSPOSE function must be the *exact dimensions* of the transposed data

{=TRANSPOSE(array)}



	A	B	C	D	E
3	20	125			
4	15	150			
5	25	120			
6	20	115			
7	15	140			
8					
9	20	15	25	20	15
10	125	150	120	115	140

*Select **A9:E10**, type "**=TRANSPOSE(A3:B7)**" and press CTRL-SHIFT-ENTER to copy the transposed data*

PRO TIP:

To transpose a data set that you may want to later edit, just use Paste Special → Transpose (ALT-H-V-T)

INTELLIGENCE WITH DATA
STRATEGY AND MASTERY

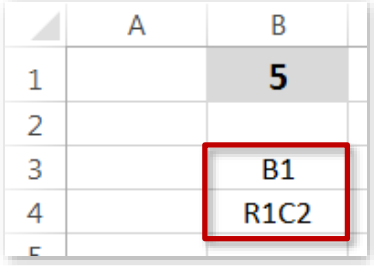
EXTRA BONUS FUNCTIONS

The INDIRECT function returns the reference specified by a text string, and can be used to change a cell reference within a formula without changing the formula itself

=INDIRECT(ref_text, [a1])

Which cell includes the text that you are evaluating?

Is your text string in **A1** format (1) or **R1C1** format (0)?



	A	B
1		5
2		
3		B1
4		R1C2

ROW(B3) = 3

ROW(INDIRECT(B3)) = 1

ROW(INDIRECT(B4,0)) = 1

*In the first **ROW** function, Excel returns the row number of cell B3, regardless of what value it contains.*

*When you add **INDIRECT**, Excel sees that cell B3 contains a reference (B1) and returns the row **of the reference***

Let's be real, the INDIRECT function is pretty confusing at first. Here are a few more examples that should give you a sense of how it works and why it can be useful:

	A	B	C	D
1	2014 Data			
2	*Product*	*Sales*		B3:B5
3	A	5		
4	B	8		A3:B5
5	C	3		A9:B11
6				
7	2015 Data			
8	*Product*	*Sales*		
9	A	12		
10	B	17		
11	C	8		

SUM(D2) = 0

SUM(INDIRECT(D2)) = 16

*The sum of "B3:B5" as a **value** doesn't make sense, but the sum of B3:B5 as a **reference** is valid – **INDIRECT** tells Excel to recognize that the cell you're referring to is a reference, not a value*

VLOOKUP("A", D4, 2, 0) = #N/A

VLOOKUP("A", INDIRECT(D4), 2, 0) = 5

***INDIRECT** will tell a **VLOOKUP** formula to use an array contained **within** a cell, rather than treat the **cell itself** as the array (which returns #N/A)*

HYPERLINK creates a shortcut that links users to a document or location within a document (which can exist on a network server, within a workbook, or via a web address)

=HYPERLINK(link_location,[friendly_name])

Where will people go if they click?

How do you want the link to read?

=HYPERLINK("http://www.example.com/report.xlsx", "Click Here")

=HYPERLINK("[C:\My Documents\Report.xlsx]", "Open Report")

=HYPERLINK("#Sheet2!A1")

PRO TIP:

Use =HYPERLINK("#"&A2&"!A1") to jump to cell A1 of the sheet name specified in A2 (note the extra single quotation marks!)