Excel: Tutorial Week 2

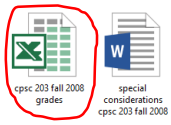
- Multiple worksheets
- Named constants
- Using pre-created functions
- Setting the format of data in a cell
- Highlighting important information via conditional formatting
- Lookup tables and lookup functions
- Counting occurrences
- The column chart

Official resource for MS-Office products: https://support.office.com

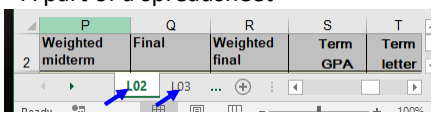
First Tutorial

Terminology

- Spreadsheet (referred to as a "workbook" by Microsoft)
  - A Microsoft **Excel file**



- **Worksheet**
  - A part of a spreadsheet



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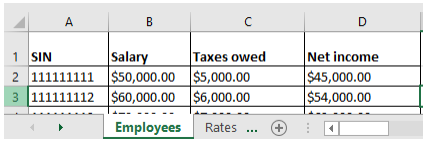
Formula References To Other Worksheets

- **Example spreadsheet**: "`references_V1_10%tax`"

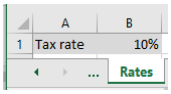
"Employees" worksheet



	A	B	C	D
1	SIN	Salary	Taxes owed	Net income
2	111111111	$50,000.00	$5,000.00	$45,000.00
3	111111112	$60,000.00	$6,000.00	$54,000.00

Employees | Rates

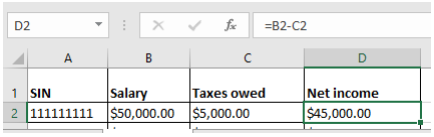
"Rates" worksheet



	A	B
1	Tax rate	10%

Rates

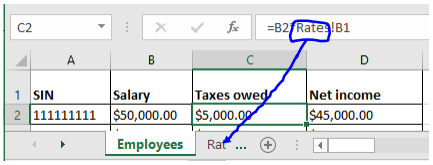
References to same worksheet



D2 =B2-C2

	A	B	C	D
1	SIN	Salary	Taxes owed	Net income
2	111111111	$50,000.00	$5,000.00	$45,000.00

Reference to **another worksheet**



C2 =B2*Rates!B1

	A	B	C	D
1	SIN	Salary	Taxes owed	Net income
2	111111111	$50,000.00	$5,000.00	$45,000.00

Employees | Rat...

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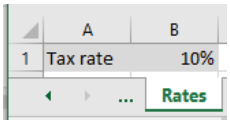
Named Constant

- The same value is referenced many times in sheet so it is defined once as a "named constant" – a constant given a name
  - Named constants: `Tax Rate = 10%, PI = 3.14`
  - **Unnamed constant**: =B2 * **0.1**



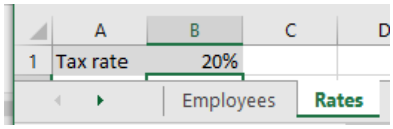
  - Named constants are typically defined and grouped in a lookup table
  - This is an example of how your assignment style marks could be affected i.e. retyping the 0.1 (poor approach, what if the weighting changes then the unnamed constant must be retyped many times)

    `= B2 * 0.1`

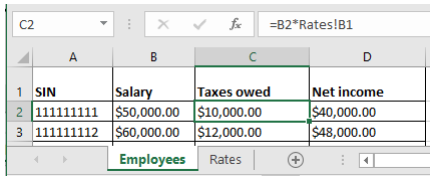
    `= B3 * 0.1`

Advantages Of Using Unnamed Constants

- **Taxes change, example spreadsheet**: `references_V1_20%tax`



- One change updates everything that refers to `!RatesB1`



- (More on this later)

Using Pre-Created Formulas

- Entering pre-created formulas, refer again to a previous example:
  - **Name of the example spreadsheet:** `functions`

Sample Data

	A	B	C	D	E	F	G	H	I	J
1	**Raw data**					**Functions (sum, round)**				
2	Fighter	Wins	Losses	Ties		Total fights (sum)	Win ratio (round)			
3	The X	10	10	10		30	0.3		SUM(B3:D3)	ROUND(B3/F3,1)
4	The Jet	50	20	1		71	0.7		etc	
5	The Bullet	100	17	0		117	0.9		etc	
6	The The	65	13	2		80	0.8		etc	
7										
8	**Functions (average, trunc)**									
9	Averages (real)	56.25	15	3.25		AVERAGE(B3:B6)	AVERAGE(C3:C6)	AVERAGE(D3:D6)		
10	Averages (whole)	56	15	3		TRUNC(B9)	etc	etc		
11										
12										
13	**Functions (count, counta, countblank)**									
14	Counting numbers	12				COUNT(A1:D6)				
15	Counting text or numbers	21				COUNTA(A1:D6)				
16	Counting empty	3				COUNTBLANK(A1:D6)				
17										
18	**Functions (min,max)**									
19	Lowest	10	10	0		MIN(B3:B6)	etc	etc		
20	Highest	100	20	10		MAX(B3:B6)	etc	etc		
21										
22										
23	Last modified (day)	2016-09-22								
24	Last modified (day/time)	2016-09-22 18:37								
25										

SUM (Col F), ROUND (Col G)

	A	B	C	D	E	F	G
1	**Raw data**					**Functions (sum, round)**	
2	Fighter	Wins	Losses	Ties		Total fights (sum)	Win ratio (round)
3	The X	10	10	10		30	0.3
4	The Jet	50	20	1		71	0.7
5	The Bullet	100	17	0		117	0.9
6	The The	65	13	2		80	0.8
8	**Functions (average, trunc)**					**Explanations of formulas (Col B - D: Row 9 - 10)**	
9	Averages (real)	56.25	15	3.25		AVERAGE(B3:B6)	AVERAGE(C3:C6)
10	Averages (whole)	56	15	3		TRUNC(B9)	etc.
11							
12							
13	**Functions (count, counta, countblank)**					**Explanations of formulas (Col B: Row 14 - 16)**	
14	Counting numbers	12				COUNT(A1:D6)	
15	Counting non empty	21				COUNTA(A1:D6)	
16	Counting empty	3				COUNTBLANK(A1:D6)	
17							
18	**Functions (min,max)**					**Explanations of formulas (Col B - D, Row 19 - 20)**	
19	Lowest	10	10	0		MIN(B3:B6)	etc.
20	Highest	100	20	10		MAX(B3:B6)	etc.
21							
22							
23	Last modified (day)	5/21/2019					
24	Last modified (day/time)	5/21/2019 17:35					

MS-Ex

AVERAGE, TRUNC

(Average: Row 9, Trunc: Row 10 – Truncates the averages from Row 9)

	A	B	C	D	E	F	G
1	**Raw data**					**Functions (sum, round)**	
2	Fighter	Wins	Losses	Ties		Total fights (sum)	Win ratio (round)
3	The X	10	10	10		30	0.3
4	The Jet	50	20	1		71	0.7
5	The Bullet	100	17	0		117	0.9
6	The The	65	13	2		80	0.8
8	**Functions (average, trunc)**					**Explanations of formulas (Col B - D: Row 9 - 10)**	
9	Averages (real)	56.25	15	3.25		AVERAGE(B3:B6)	AVERAGE(C3:C6)
10	Averages (whole)	56	15	3		TRUNC(B9)	etc.
11							
12							
13	**Functions (count, counta, countblank)**					**Explanations of formulas (Col B: Row 14 - 16)**	
14	Counting numbers	12				COUNT(A1:D6)	
15	Counting non empty	21				COUNTA(A1:D6)	
16	Counting empty	3				COUNTBLANK(A1:D6)	
17							
18	**Functions (min,max)**					**Explanations of formulas (Col B - D, Row 19 - 20)**	
19	Lowest	10	10	0		MIN(B3:B6)	etc.
20	Highest	100	20	10		MAX(B3:B6)	etc.
21							
22							
23	Last modified (day)	5/21/2019					
24	Last modified (day/time)	5/21/2019 17:35					

MS-I

Counting functions (Col B, Rows 14 - 16)

(Count: Row 14, CountA: Row 15, CountBlank: Row 16)

	A	B	C	D	E	F	G
1	**Raw data**					**Functions (sum, round)**	
2	Fighter	Wins	Losses	Ties		Total fights (sum)	Win ratio (round)
3	The X	10	10	10		30	0.3
4	The Jet	50	20	1		71	0.7
5	The Bullet	100	17	0		117	0.9
6	The The	65	13	2		80	0.8
8	**Functions (average, trunc)**					**Explanations of formulas (Col B - D: Row 9 - 10)**	
9	Averages (real)	56.25	15	3.25		AVERAGE(B3:B6)	AVERAGE(C3:C6)
10	Averages (whole)	56	15	3		TRUNC(B9)	etc.
11							
12							
13	**Functions (count, counta, countblank)**					**Explanations of formulas (Col B: Row 14 - 16)**	
14	Counting numbers	12				COUNT(A1:D6)	
15	Counting non empty	21				COUNTA(A1:D6)	
16	Counting empty	3				COUNTBLANK(A1:D6)	
17							
18	**Functions (min,max)**					**Explanations of formulas (Col B - D, Row 19 - 20)**	
19	Lowest	10	10	0		MIN(B3:B6)	etc.
20	Highest	100	20	10		MAX(B3:B6)	etc.
21							
22							
23	Last modified (day)	5/21/2019					
24	Last modified (day/time)	5/21/2019 17:35					

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MIN, MAX (Row 19 – 20, Col B - D)

	A	B	C	D	E	F	G
1	**Raw data**					**Functions (sum, round)**	
2	Fighter	Wins	Losses	Ties		Total fights (sum)	Win ratio (round)
3	The X	10	10	10		30	0.3
4	The Jet	50	20	1		71	0.7
5	The Bullet	100	17	0		117	0.9
6	The The	65	13	2		80	0.8
8	**Functions (average, trunc)**					**Explanations of formulas (Col B - D: Row 9 - 10)**	
9	Averages (real)	56.25	15	3.25		AVERAGE(B3:B6)	AVERAGE(C3:C6)
10	Averages (whole)	56	15	3		TRUNC(B9)	etc.
11							
12							
13	**Functions (count, counta, countblank)**					**Explanations of formulas (Col B: Row 14 - 16)**	
14	Counting numbers	12				COUNT(A1:D6)	
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16	Counting empty	3				COUNTBLANK(A1:D6)	
17							
18	**Functions (min,max)**					**Explanations of formulas (Col B - D, Row 19 - 20)**	
19	Lowest	10	10	0		MIN(B3:B6)	etc.
20	Highest	100	20	10		MAX(B3:B6)	etc.
21							
22							
23	Last modified (day)	5/21/2019					
24	Last modified (day/time)	5/21/2019 17:35					

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Time Information: TODAY (B23), NOW (B24)

	A	B	C	D	E	F	G
1	**Raw data**					**Functions (sum, round)**	
2	Fighter	Wins	Losses	Ties		Total fights (sum)	Win ratio (round)
3	The X	10	10	10		30	0.3
4	The Jet	50	20	1		71	0.7
5	The Bullet	100	17	0		117	0.9
6	The The	65	13	2		80	0.8
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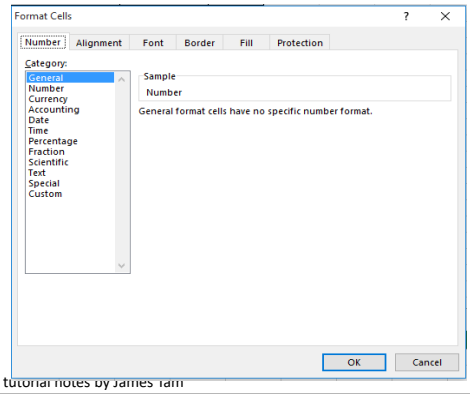
9	Averages (real)	56.25	15	3.25		AVERAGE(B3:B6)	AVERAGE(C3:C6)
10	Averages (whole)	56	15	3		TRUNC(B9)	etc.
11							
12							
13	**Functions (count, counta, countblank)**					**Explanations of formulas (Col B: Row 14 - 16)**	
14	Counting numbers	12				COUNT(A1:D6)	
15	Counting non empty	21				COUNTA(A1:D6)	
16	Counting empty	3				COUNTBLANK(A1:D6)	
17							
18	**Functions (min,max)**					**Explanations of formulas (Col B - D, Row 19 - 20)**	
19	Lowest	10	10	0		MIN(B3:B6)	etc.
20	Highest	100	20	10		MAX(B3:B6)	etc.
21							
22							
23	Last modified (day)	5/21/2019					
24	Last modified (day/time)	5/21/2019 17:35					

Setting The Format Of Cell Data

- **Name of the example spreadsheet**: `data_types`
- Setting the data type (again right click and select '`Format Cells`')
  - Reminder: The '`Number`' tab is the default selection



Examples Of Different Types

	A	B	C
1	**Data type**	**Examples**	
2	Number	123.45	22.50
3	Currency	$999.99	-$777.00
4	Accounting	$ 12.35	-$ 12.35
5	Percentage	80.00%	
6	Fraction	1/4	
7	Scientific	3.33E-01	
8	Text (default: left align)	-12.35	
9	Special (regular phone number)	123-4567	
10	Custom (HK format phone number)	1-234567	

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Conditional Formatting

- **Example spreadsheet:** `conditional_formatting`
- It can be used to visually highlight data which has met a certain condition (e.g. 6 figure sales volume or higher in 2017).

	A	B
1	**Employee**	**2017 sales in $**
2	James	$100,000
3	Dave	$123,456
4	Ernie	$55,000
5	Ron	$66,000
6	Don	$118,000
7	Lucie	$75,000

- Can either be used to:
  - Assign specific colors *when a condition is met* (e.g. red for all finance employees and blue for marketing)
  - Assign a range or gradient of colors depending upon *to what degree* that a condition is met (e.g. red for high income, darker for higher values)

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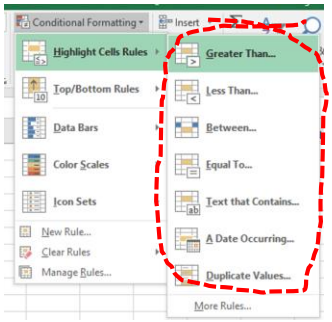
Setting Conditional Formatting

- `Home -> Styles: Conditional formatting`



If you don't know much about visual design then keep it simple, stick to the basics (highlighting only if a condition is met rather than setting gradients for the degree to which a condition is met)

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Conditional Formatting Exercise

- **Student exercise**: modify spreadsheet "`conditional_formatting_exercise`" so that the cells are colored under the following conditions:
- Time is less than 240 seconds
- Age is greater than 50 years
- *One exam*ple solution

	A	B	C
1	**Runner**	**Time**	**Age**
2	Roadrunner	233	24
3	Roadkill	239	18
4	Bugsy	220	21
5	Speedy	347	25
6	Shoeman	421	50
7	Quigly	420	88
8	Taman	240	35

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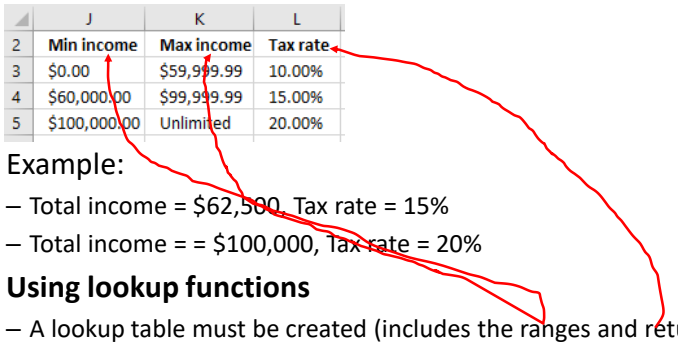
Second Tutorial

Lookup Functions

- One application: finding which range does a numerical value fall into.



	J	K	L
2	**Min income**	**Max income**	**Tax rate**
3	$0.00	$59,999.99	10.00%
4	$60,000.00	$99,999.99	15.00%
5	$100,000.00	Unlimited	20.00%

- Example:
  - Total income = $62,500, Tax rate = 15%
  - Total income = = $100,000, Tax rate = 20%
- **Using lookup functions**
  - A lookup table must be created (includes the ranges and return value once the range is determined).

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Lookup Tables/VLOOKUP

- Important lookup table requirements
  - Lookup tables for these VLOOKUP examples **must be in ascending order**.

	J	K	L
2	**Min income**	**Max income**	**Tax rate**
3	$0.00	$59,999.99	10.00%
4	$60,000.00	$99,999.99	15.00%
5	$100,000.00	Unlimited	20.00%

  - **Cell references** to the lookup table must be **preceded by a dollar sign** e.g. `$J$3:$L$5` (this ensures that the function will always lookup the same range for the cells of the lookup table).

VLOOKUP: Format

```
VLOOKUP(<Lookup value>,
        <Lookup table  Start : End>,
        <Lookup table Column specifying the return value>)
```

- **Example spreadsheet**: `salaries_vlookup_function`

F2 =VLOOKUP(E2,$J$3:$L$5,3)

	A	B	C	D	E	F
1	**Employee**	**Salary**	**Bonus**	**Stock options**	**Total compensation**	**Tax rate**
2	1	$100,000.00	$1,000.00		$101,000.00	20.00%
3	2	$75,000.00	$4,000.00		$79,000.00	15.00%
4	3	$55,000.00	$30,000.00		$85,000.00	15.00%
5	4	$130,000.00	$85,000.00		$215,000.00	20.00%
6	5	$1.00		$540,000.00	$540,001.00	20.00%

How interpret =VLOOKUP(E2,$J$3:$L$3,3)

- E2 is the salary
- Lookup table is from J3 – L5
- Return value from Col 3 in the table (tax rate)

	J	K	L
2	**Min income**	**Max income**	**Tax rate**
3	$0.00	$59,999.99	10.00%
4	$60,000.00	$99,999.99	15.00%
5	$100,000.00	Unlimited	20.00%

Crucial Points When Defining Lookup Tables

- Given the usage of the VLOOKUP function that you have been taught (finding which range does a numerical value fall into) your lookup tables **must** be sorted in ascending order.
- Also the values in the first column can **only** be numeric

Correct

Min income	Max income	Tax rate
0	Under $20,000	0%
20000	Under $50,000	10%
50000	Unlimited	15%

Incorrect

Min income	Max income	Tax rate
50000	Unlimited	15%
20000	Under $50,000	10%
0	Under $20,000	0%

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Types Of Formula Errors In Excel

- **Syntax error** (occurs when the syntax, or rules, of defining the formula have been violated):
  - A pre-created Excel formula is **incorrectly named** or has incorrect arguments e.g. =**AVERIGE**(A1:F10), =IF("Hello",C2,A2)
  - Excel will provide clues when a syntax error has occurred.
  - #NAME? (There is no formula named 'AVERIGE')
  - #VALUE! (A value or argument has been specified incorrectly)
- **Logic error** (occurs when the logic, or value produced, by the formula is wrong):
  - A formula is **specified incorrectly** e.g. area of a rectangular property is specified using addition rather than multiplication (=A1+B1)
  - Logic errors are more difficult to find and fix.

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Finding And Fixing Logic Errors

- Testing the formula is one approach for 'debugging'/finding & fixing the error/bug (e.g. enter 4 and 3 into Cells A1 and B1 respectively and see if the expected value of 12 is returned by the formula
  - This error is easy to catch, not all logic errors will be this easy.
    - That's why there are bugs in actual commercial programs.
  - Two things to look for when debugging logic errors:
    1. Check the input data is correct
       - E.g. area of circle: $A = \Pi * r^2$, $A = 1.34 * 10^2$ incorrectly uses 1.34 instead of 3.14
    2. Check the formula is correctly specified
       - E.g. area of a rectangle = width * length, A = w + l incorrectly uses addition instead of multiplication

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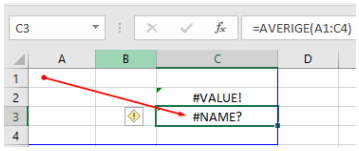
Excel's Built-In Tools For Dealing With Errors



- Trace Precedents and dependents
  - **Precedents**: "Cells that are referred to by a formula in another cell"[1]
    - e.g. Cell C3 contains the formula `=A1*0.1`
    - A1 is the precedent for C3
  - **Dependents**: "these cells contain formulas that refer to other cells" [1]
    - e.g. Cell B6 contains the formula `=10-B3`
    - **Cell B6** is the dependent of Cell B3
  - Accessing the tracing feature:
    - `Formulas -> Formula auditing: {Trace Precedents / Trace Dependents}`

More information on Excel's built in help for errors:
1 https://support.office.com/en-us/article/Display-the-relationships-between-formulas-and-cells-a59bef2b-3701-46bf-8ff1-d3518771d507

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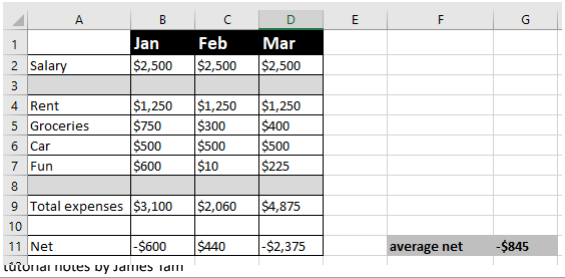
Example: Precedents & Dependents

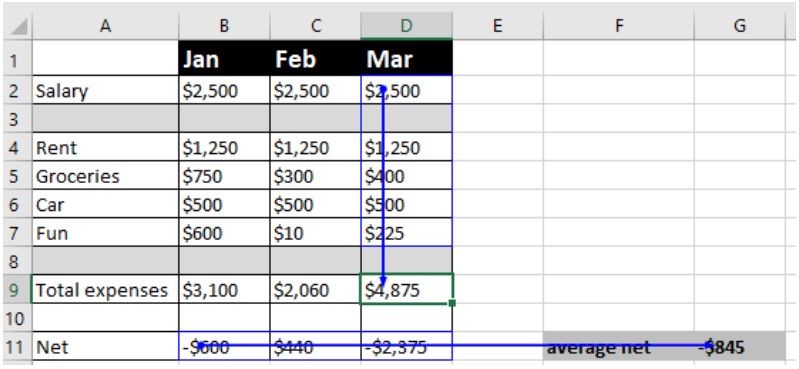
- A spreadsheet that tracks net income (salary minus all expenses).
- Average net (G11) is the average net income for all 3 months
- There is an error in the spreadsheet.
  - It's easy to spot the error in a small spreadsheet like the one below.
  - But a complicated example will make it harder to see how the tracing feature of Excel works.



	A	B	C	D	E	F	G
1		**Jan**	**Feb**	**Mar**			
2	Salary	$2,500	$2,500	$2,500			
3							
4	Rent	$1,250	$1,250	$1,250			
5	Groceries	$750	$300	$400			
6	Car	$500	$500	$500			
7	Fun	$600	$10	$225			
8							
9	Total expenses	$3,100	$2,060	$4,875			
10							
11	Net	-$600	$440	-$2,375		**average net**	**-$845**

Example: Using Precedents To Error Trace

- **Example spreadsheet**: `finding_fixing_errors`
- This shows which cells have values that are dependent upon (values are affected by the contents of) of other cells.



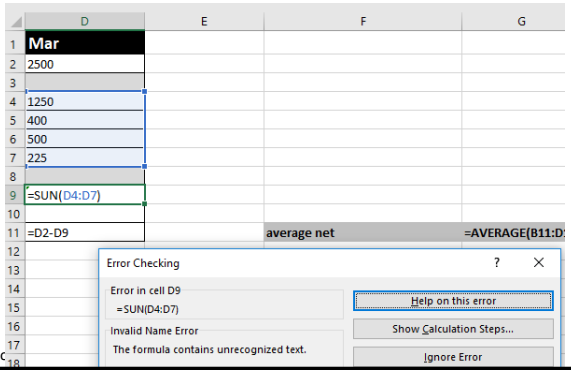
	A	B	C	D	E	F	G
1		**Jan**	**Feb**	**Mar**			
2	Salary	$2,500	$2,500	$2,500			
3							
4	Rent	$1,250	$1,250	$1,250			
5	Groceries	$750	$300	$400			
6	Car	$500	$500	$500			
7	Fun	$600	$10	$225			
8							
9	Total expenses	$3,100	$2,060	$4,875			
10							
11	Net	-$600	$440	-$2,375		**average net**	**-$845**

Finding Syntax Errors

	A	B	C	D	E	F	G
1		**Jan**	**Feb**	**Mar**			
2	Salary	$2,500	$2,500	$2,500			
3							
4	Rent	$1,250	$1,250	$1,250			
5	Groceries	$750	$300	$400			
6	Car	$500	$500	$500			
7	Fun	$600	$10	$225			
8							
9	Total expenses	$3,100	$2,060	#NAME?			
10							
11	Net	-$600	$440	#NAME?		**average net**	**#NAME?**

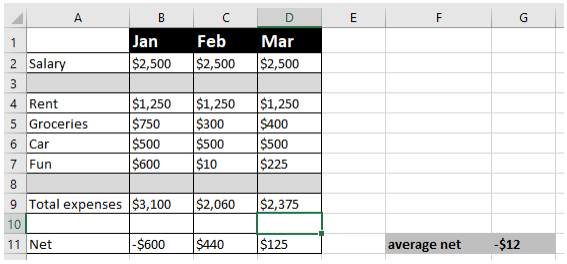
Finding Syntax Errors (2)

- If you can't spot the syntax error by manually scanning formulas (e.g. spreadsheet is too large) then there's an automated mechanism.
  - `Formulas : Formula auditing : Error checking -> Error checking`



Finding Syntax Errors (3)

- Sometimes fixing the error in the original precedent cell will fix several errors.
  - The example below shows the result of correcting the formula in Cell D9.
  - Syntax errors in other cells D11 and G11 are automatically fixed.



	A	B	C	D	E	F	G
1		**Jan**	**Feb**	**Mar**			
2	Salary	$2,500	$2,500	$2,500			
3							
4	Rent	$1,250	$1,250	$1,250			
5	Groceries	$750	$300	$400			
6	Car	$500	$500	$500			
7	Fun	$600	$10	$225			
8							
9	Total expenses	$3,100	$2,060	$2,375			
10							
11	Net	-$600	$440	$125		**average net**	**-$12**

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Circular References

- A specific type of error when a cell containing a formula includes that cell in the formula.
- Cell A10 contains the formula: =AVERAGE(A1:A10).

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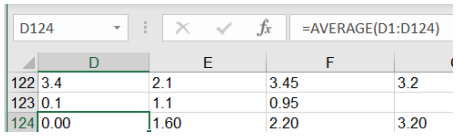
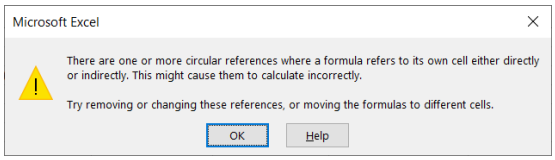
Finding Circular References

- Example
  - To make it easy to see how things work you are shown exactly which cell contains the circular reference.

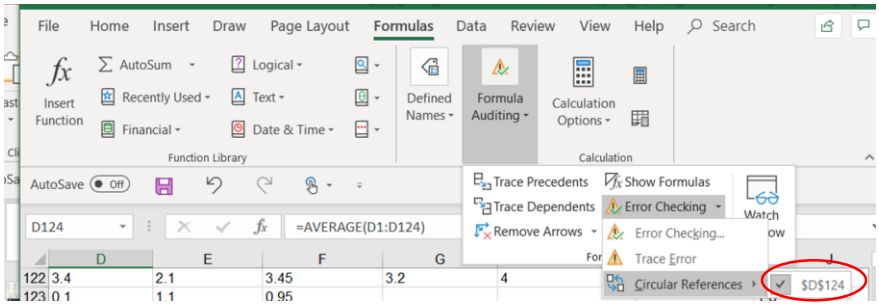


- **One clue**: After the formula has been entered Excel will provide an alert that a circular reference exists



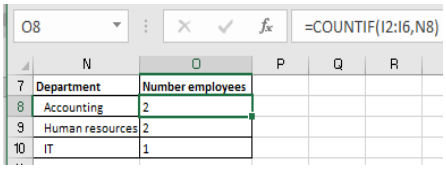
Finding Circular References

- **Finding the problem afterward**: you can use the built in mechanism for finding circular references:
- Formulas : Calculations : Error Checking -> Circular references



The COUNTIF() Function

- **Example spreadsheet:** `countif`
- Counts (adds to a tally when a cell in a range meets a condition) e.g. # of IT employees
- Example: For the formula in Cell O8 whenever a cell in the range `I2:I6` contain the string in Cell N8 "Accounting" one is added to the tally.
  - In other words it counts the number of employees from the accounting department



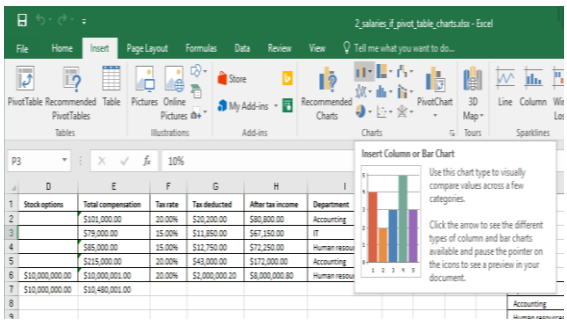
	N	O	P	Q	R
7	Department	Number employees			
8	Accounting	2			
9	Human resources	2			
10	IT	1			

Employee info

	I
1	Department
2	Accounting
3	IT
4	Human resources
5	Accounting
6	Human resources

Inserting A Column Chart

- "Insert" the chart: `Insert -> Charts:` (Select a column chart)



- Keep it simple e.g. avoid fancy 3D effects
  - Avoid "chart junk" – look up this bad design practice online (described by Edward Tufte) for more details

Other Excel Resources

- Online training resources created by Microsoft:
  - Tutorials
    - https://support.office.com/en-us/article/excel-for-windows-training-9bc05390-e94c-46af-a5b3-d7c22f6990bb
  - A MAC specific resource
    - https://support.office.com/en-us/article/excel-2016-for-mac-help-2010f16b-aec0-4da7-b381-9cc1b9b47745

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