

2001 financial statements.xlsx - Microsoft Excel												
Home Insert Page Layout Formulas Data Review View Load Test Team												
Clipboard		Font		Alignment			Number		Styles		Cells	
AF52	f(x)											
1	Consolidated Statements of Shareholders' Equity											
2	[DOLLARS IN THOUSANDS]											
3												
4												
5												
6												
7												
8												
9	Balance, January 1, 1999	69,494	483	\$ 86,868	\$ 43,281	\$ 604,227	\$ (21,902)	\$ (12,802)	\$ (549)	\$ 699,123		
10												
11	Net income					128,856						128,856
12	Translation adjustment											9,558
13	Pensions											614
14	Unrealized loss on investment securities											(3,235)
15	Other comprehensive income											
16	Comprehensive income											
17	Stock options exercised	108,104		134		1,918						2,052
18	Unearned compensation	149,799		188		3,933						636
19	Performance shares	20,397		26		686						712
20	Procomp and Nexus acquisitions	1,710,214		2,138		37,351						48,976
21	Dividends declared and paid					(41,668)						(41,668)
22	Treasury shares											(1,229)
23												
24	Balance, December 31, 1999	71,482	997	\$ 89,354	\$ 87,169	\$ 691,415	\$ (13,644)	\$ (5,865)	\$ (4,034)	\$ 844,395		
25	Net income					136,919						136,919
26	Translation adjustment											(7,904)
27	Pensions											1,507
28	Unrealized loss on investment securities											(396)
29	Other comprehensive loss											(6,793)
30	Comprehensive income											(6,793)
31	Stock options exercised	273,238		343		5,444						5,787
32	Unearned compensation	247,635		308		5,583						1,976
33	Performance shares	15,335		19		334						353
34	Dividends declared and paid					(44,271)						(44,271)
35	Treasury shares											(2,300)
36												
37	Balance, December 31, 2000	536,208	\$ 90,024	\$ 98,530	\$ 784,063	\$ (15,944)	\$ (12,658)	\$ (7,949)	\$ 936,066			
38	Net income					66,893						66,893
39	Translation adjustment											(47,373)
40	Pensions											(1,628)
41	Unrealized gain on investment securities											1,213
42	Other comprehensive loss											(47,788)
43	Comprehensive income											(47,788)
44	Stock options exercised	176,395		221		4,860						5,081
45	Unearned compensation											1,412
46	Dividends declared and paid					(45,774)						(45,774)
47	Treasury shares											(12,780)
48												
49	Balance, December 31, 2001	712,603	\$ 90,245	\$ 103,390	\$ 805,182	\$ (28,724)	\$ (60,446)	\$ (6,537)	\$ 903,110			
50												
51												

# Spreadsheets for developers

## Felienne Hermans

@Felienne

Consolidated Statements of Shareholders' Equity												
	A	B	C	D	E	F	G	H	I	J	K	L
1	Consolidated Statements of Shareholders' Equity											
2	[DOLLARS IN THOUSANDS]											
3												
4												
5												
6												
7												
8												
9	Balance, January 1, 1999											
10												
11	Net income											
12	Translation adjustment											
13	Pensions											
14	Unrealized loss on investment securities											
15	Other comprehensive income											
16	Comprehensive income											
17	Stock options exercised	108,104		134		1,918						
18	Unearned compensation	149,799		188		3,933						
19	Performance shares	20,397		26		686						
20	Procomp and Nexus acquisitions	1,710,214		2,138		37,351						
21	Dividends declared and paid						(41,668)					
22	Treasury shares							(1,229)				
23												
24	Balance, December 31, 1999	71,482,997	\$	89,354	\$	87,169	\$	691,415	\$	(13,644)	\$	(5,865)
25	Net income											
26	Translation adjustment											
27	Pensions											
28	Unrealized loss on investment securities											
29	Other comprehensive loss											
30	Comprehensive income											
31	Stock options exercised	273,238		343		5,444						
32	Unearned compensation	247,635		308		5,583						
33	Performance shares	15,335		19		334						
34	Dividends declared and paid							(44,271)				
35	Treasury shares								(2,300)			
36												
37	Balance, December 31, 2000	536,208	\$	90,024	\$	98,530	\$	784,063	\$	(15,944)	\$	(12,658)
38	Net income											
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41	Unrealized gain on investment securities											
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44	Stock options exercised	176,395		221		4,860						
45	Unearned compensation											
46	Dividends declared and paid											
47	Treasury shares											
48												
49	Balance, December 31, 2001	712,603	\$	90,245	\$	103,390	\$	805,182	\$	(28,724)	\$	(60,446)
50												
51												

So you are a developer? Why should you bother to learn spreadsheets?

In this deck, I explain you why.

Home Insert Page Layout Formulas Data Review View Load Test Team

Cut Copy Format Painter Clipboard

Arial 10 A A Wrap Text General \$ % , Alignment Number Conditional Formatting as Table Styles Insert Cells AutoSum Fill Sort & Filter Find & Select

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AF52 fx

1 Consolidated Statements of Shareholders' Equity [DOLLARS IN THOUSANDS]

2 Balance, January 1

3

4

5

6

7

8

9 Additional Capital Retained Earnings Treasury Comprehensive Other

10 Value \$ 43,281 \$ 604,227 \$ (1,902) \$ (12,602) \$ (549) \$ 699,123

11 Net income 128,856

12 Translation adjustment 9,558

13 Pensions 614

14 Unrealized loss on investments (3,235)

15 Other comprehensive income 2,052

16 Comprehensive income 48,976

17 Stock options exercised 13,400

18 Unearned compensation 3,933

19 Performance shares 2,997

20 Procomp and Nexus acquisitions 1,710,214

21 Dividends declared and paid (41,668)

22 Treasury shares (1,229)

23

24 Balance 9,487

25 Net income 87,169

26 Translation adjustment 136,919

27 Pensions (7,904)

28 Unrealized loss on investments (3,993)

29 Other comprehensive income 5,787

30 Comprehensive income 136,919

31 Stock options 5,583

32 Unearned compensation (7,904)

33 Performance shares 334

34 Dividends (44,271)

35 Treasury shares (2,300)

36

37 Balance 98,530

38 Net income 784,063

39 Translation adjustment (15,944)

40 Pensions \$ (12,658)

41 Unrealized loss on investments (7,949)

42 Other comprehensive income 936,066

43 Comprehensive income 66,893

44 Stock options (47,373)

45 Unearned compensation (1,628)

46 Dividends declared and paid 1,213

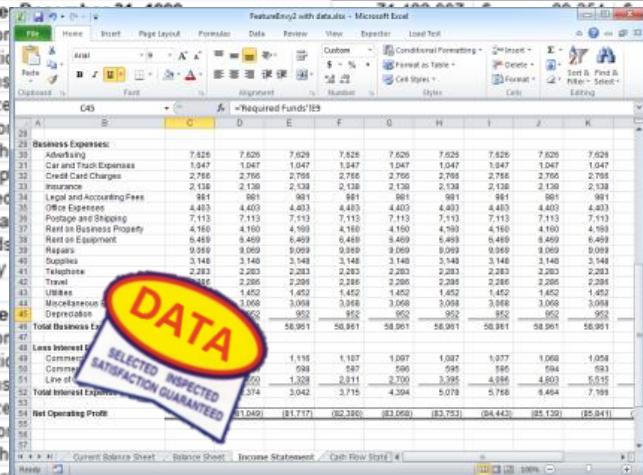
47 Treasury shares (47,788)

48

49 Balance, December 31, 2001 712,603 \$ 90,245 \$ 103,390 \$ 805,182 \$ (28,724) \$ (60,446) \$ (6,537) \$ 903,110

50

51

**So you are a developer? Why should you bother to learn spreadsheets?**

**In this deck, I explain you why.**

**People often think about spreadsheets as data, but that is a gross misslabeling.**

A photograph of a gospel choir performing on stage. The choir members are dressed in shiny gold robes over white shirts, singing into microphones. The background is dark, and stage lights are visible.

**Spreadsheets are code**

A photograph of a gospel choir performing on stage. The men are wearing shiny, reflective gold robes over white shirts. They are singing into microphones, with their mouths open and expressions of passion. The background is dark, making the gold robes stand out.

# Spreadsheets are code

I have made it my life's work to  
spread the happy word

“Spreadsheets are code!”

A photograph of a gospel choir performing on stage. The men are wearing shiny gold robes and white shirts. They are singing into microphones and have their mouths open. The background is dark, and the stage lights reflect off the robes.

# Spreadsheets are code

I have made it my life's work to  
spread the happy word

“Spreadsheets are code!”

If you don't immediately believe  
me, I have three reasons\*

\* If you do believe me, skip the next 10 slides ;)

A photograph of a gospel choir performing on stage. The choir members are wearing shiny, metallic gold robes over white shirts. They are singing into microphones, with some members having their mouths wide open. The background is dark, and stage lights are visible.

**Spreadsheets are code**

Spreadsheet\_5.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA BumbleBee Expector Load Test Team

Clipboard Paste

G35 =F21^2

	A	B	C	D	E	F	G	H	I
20									
21	Enter the annualized standard deviation in reinvestment						61.25%	(in %)	
22									
23	<b>Inputs relating to the option</b>								
24	Enter reinvestment needs that can be financed without						5.00%	(in currency)	
25	Enter maximum reinvestment that can be financed with						17.00%		
26	<b>General Inputs</b>								
27	Enter the riskless rate that corresponds to the option life						6.00%	(in %)	
28									
29	<b>Capital Inputs</b>								
30	Enter the current cost of capital for the firm =						12.22%		
31	Enter the firm's current return on capital =						18.69%		
32									
33	<b>Output</b>	<b>1) Used for similar problems</b>							
34	Stock Price=	9.13%	T.Bond rate=	6.00%					
35	Strike Price=	5.00%	Variance=	0.3751616					
36	Expiration (in years) =	1	Annualized dividend yield=	0.00%					
37	Annual Excess Return=	6.47%	Cost of Capital =	12.22%					
38	Maximum Flexibility =	17.00%							
	Reinvestment Needs	Value of Flexibility							
Ready			100%						

Spreadsheet\_5.xlsx - Microsoft Excel

This tool (for stock price computation) could have been built in any language. C, JavaScript, COBOL, or Excel.

The problems Excel is used for are often (not always) similar to problems solved in different languages.

	Reinvestment Needs	Value of Flexibility	
Stock Price =	9.13%	T. Bond rate =	6.00%
Strike Price =	5.00%	Variance =	0.3751616
Expiration (in years) =	1	Annualized dividend yield =	0.00%
Annual Excess Return =	6.47%	Cost of Capital =	12.22%
Maximum Flexibility =	17.00%		

A screenshot of Microsoft Excel with the title "Turing Machine\_Successor.xlsx - Microsoft Excel". The ribbon menu is visible at the top, showing tabs like File, Home, Insert, Page Layout, Formulas, Data, Review, View, Add-Ins, VBA, Load Test, BumbleBee, Expector, and various icons for clipboard, font, alignment, number, styles, cells, and editing. The main worksheet area shows a grid of cells. Row 1 contains labels A through Q. Row 2 contains values 14 and 4 followed by several arrows pointing left. Rows 4 through 30 show states and transitions, with columns D, F, and G highlighted in yellow. A large block of text is overlaid on the right side of the grid, reading: "I go to great lengths to make my point. To such great lengths that I built a Turing machine in Excel, using formulas only." The bottom navigation bar includes tabs for Machine, State Table, Directions, and a small icon. The status bar at the bottom shows "Ready Calculate" and "90%".

File	Home	Insert	Page Layout	Formulas	Data	Review	View	Add-Ins	VBA	Load Test	BumbleBee	Expector	Σ	A	Z	Cells	Sort & Filter	Find & Select
Clipboard	Font		Alignment				Number		Styles		Cells		Editing					
	A1				f <sub>x</sub>													
1		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
2				14	4 <---													
3																		
4	4 S1	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
5	5 S1	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
6	6 S1	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
7	7 S1	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
8	8 S2	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
9	9 S2	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
10	10 S2	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
11	9 S3	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
12	8 S3	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
13	7 S3	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
14	6 S3	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
15	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
16	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
17	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
18	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
19	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
20	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
21	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
22	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
23	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
24	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
25	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
26	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
27	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
28	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
29	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-
30	7 S4	-	-	-	-	1	1		1	-	-	-	-	-	-	-	-	-

Here you see it in action. Every row is an consecutive step of the tape.

This makes it, in addition to a proof that formulas are Turing complete, Also a nice visualization of a Turing machine.

[SUBMIT A LINK](#)[FEATURES](#)[REVIEWS](#)[PODCASTS](#)[VIDEO](#)[FORUMS](#)[MORE ▾](#)

Here you see it in action. Every row  
is an consecutive step of the tape.

# Implementing a Turing machine in Excel

Cory Doctorow at 2:20 pm Fri, Sep 20, 2013



142



Submit

24

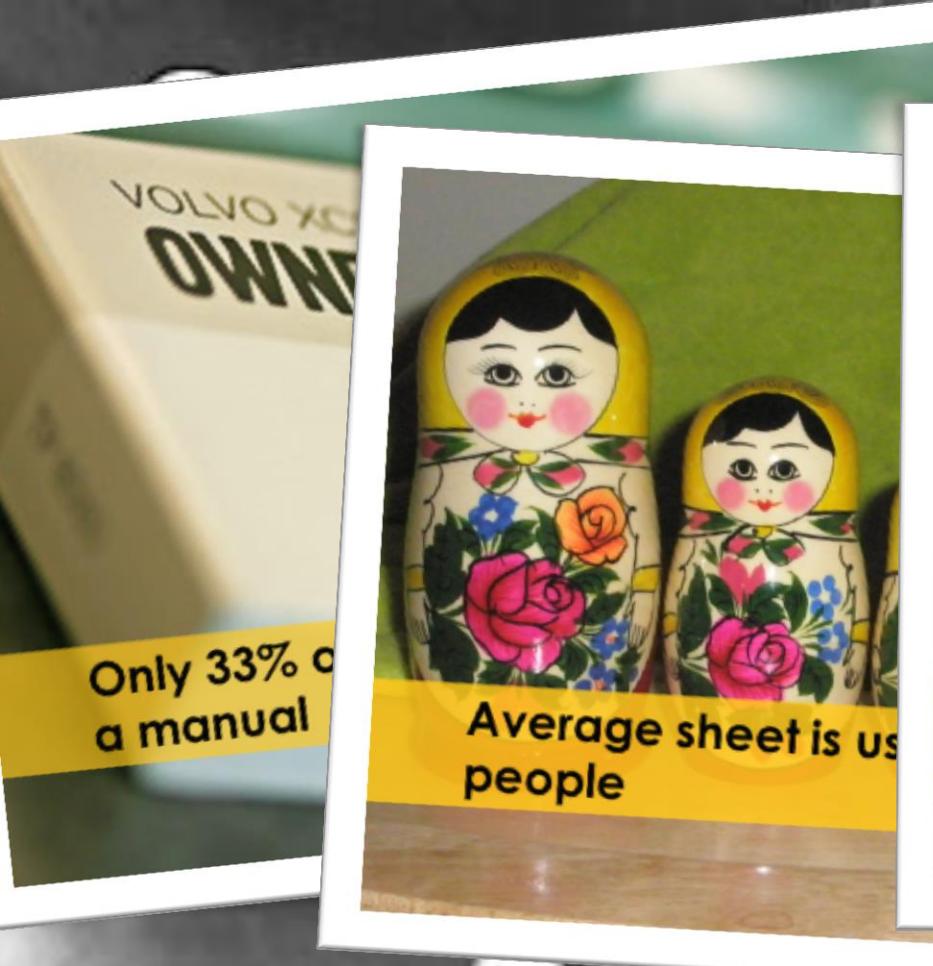


A screenshot of Microsoft Excel showing a grid of binary values (0s and 1s) in a table. The grid consists of approximately 20 columns and 30 rows. The first few columns contain labels like 'SUM', 'fx', and 'Autosum'. The formula bar shows a complex VLOOKUP formula: =IFERROR(VLOOKUP(VLOOKUP(\$B\$4&"-&(INDEX(\$A:\$M,\$A4),StateTable,5,0),DirectionTable,2,0),0))=1. The data in the grid represents the state transitions of a Turing machine tape over time steps.

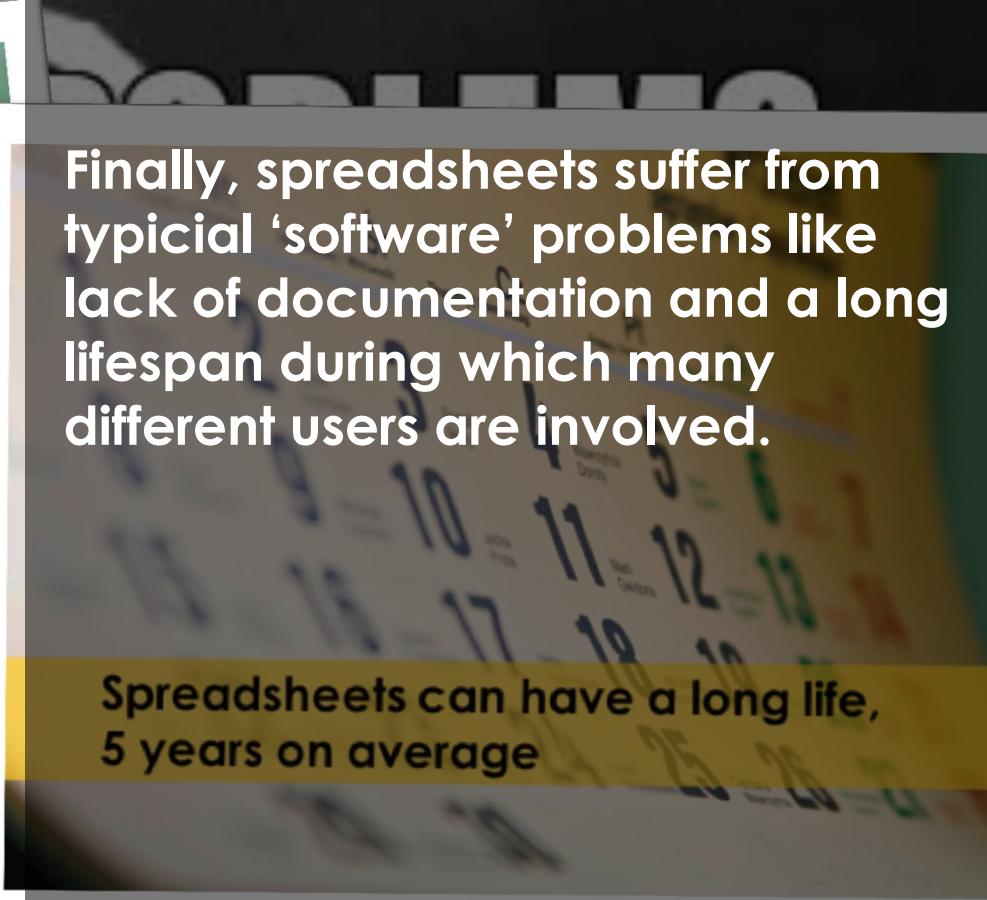
Many people liked it :)



## 2) Formulas are Turing complete



### 3) They suffer from the same problems



Finally, spreadsheets suffer from typical 'software' problems like lack of documentation and a long lifespan during which many different users are involved.

A photograph of a gospel choir performing on stage. Seven men are visible, all wearing shiny gold robes over white shirts. They are singing into microphones, their mouths open in harmony. The background is dark, and stage lights are visible.

**Spreadsheets are code**

**In summary: both the activities,  
complexity and problems are the same**

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11	Net income				128,856		\$ 128,856						128,856	
12	Translation adjustment						9,558						9,558	
13	Pensions						614						614	
14	Unrealized loss on investment securities						(3,235)						(3,235)	
15	Other comprehensive income						6,937		6,937					
16	Comprehensive income						\$ 135,793							
17	Stock options exercised	108,104	134	1,918									2,052	
18	Unearned compensation	149,799	188	3,933									636	
19	Performance shares	20,397	26	686									712	
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25	Net income				136,919		\$ 136,919						136,919	
26	Translation adjustment						(7,904)						(7,904)	
27	Pensions						1,507						1,507	
28	Unrealized loss on investment securities						(396)						(396)	
29	Other comprehensive loss						(6,793)		(6,793)				(6,793)	
30	Comprehensive income						\$ 130,126							
31	Stock options exercised	273,238	343	5,444									5,787	
32	Unearned compensation	247,635	308	5,583									1,976	
33	Performance shares	15,335	19	334			(44,271)						353	
34	Dividends declared and paid						(2,300)						(44,271)	
35	Treasury shares												(2,300)	
36														
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38	Net income				66,893		\$ 66,893						66,893	
39	Translation adjustment						(47,373)						(47,373)	
40	Pensions						1,628						1,628	
41	Unrealized gain on investment securities						1,213						1,213	
42	Other comprehensive loss						(47,788)		(47,788)				(47,788)	
43	Comprehensive income						\$ 19,105							
44	Stock options exercised	176,395	221	4,860									5,081	
45	Unearned compensation												1,412	
46	Dividends declared and paid				(45,774)								(45,774)	
47	Treasury shares						(12,780)						(12,780)	
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49	Balance, December 31, 2001	712,603	\$ 90,245	\$ 103,390	\$ 805,182	\$ (28,724)	\$ (60,446)	\$ (6,537)	\$ 903,110					
50														
51														

And not just a programming language!

A close-up photograph of a Star Trek Borg character's head. The character has a bald, wrinkled forehead and is wearing a dark, metallic Borg helmet. The helmet features a circular visor over the eyes and various mechanical components, including a small screen or sensor on top. Wires run from the helmet down the sides of his head and neck. The background is dark and out of focus.

I argue that Excel is  
the next language  
to learn

Resistance is futile!

# live programming



```
canvasHeight = parseInt(canvas.getAttribute("height"));
```

```
drawSky();  
drawMountains();  
drawTree();
```

Spreadsheet are ‘live  
programming’ avant la lettre.

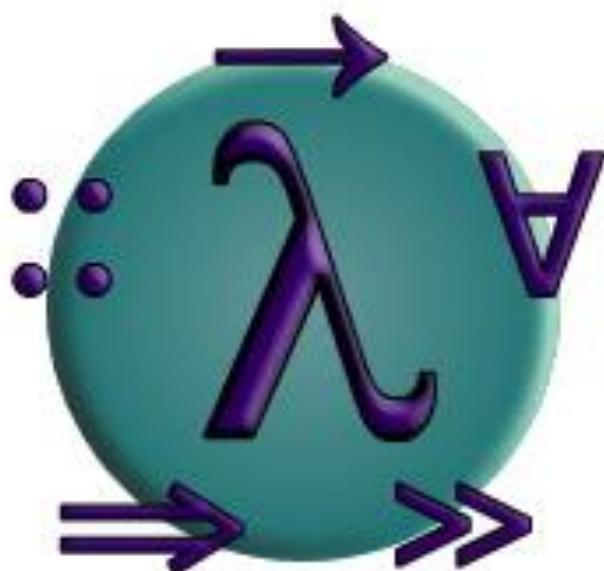
```
function drawSky () {  
    ctx.save();  
    gradient.addColorStop(0, "#b4e0fa");  
    gradient.addColorStop(1, "#d9ead3");  
    ctx.fillStyle = gradient;  
    ctx.fillRect(0, 0, width, canvasHeight);  
    ctx.restore();  
}
```

What Bret Victor is been  
advocating for lately, we had that  
since VisiCalc!

Just type up your formula and you  
will get the result immediately.

```
//  
  
function drawMountains () {  
    resetRandom();  
  
    drawMountain(130, "#8bb2bb");  
    drawMountain(50, "#618087");  
}
```

**pure functional**



You love pure functional  
languages?

# Haskell

*A Purely Functional Language*

featuring static typing, higher-order functions,  
polymorphism, type classes and monadic effects

**pure functional**



***A Purely Functional Language***  
featuring static typing, higher-order functions,  
polymorphism, type classes and monadic effects

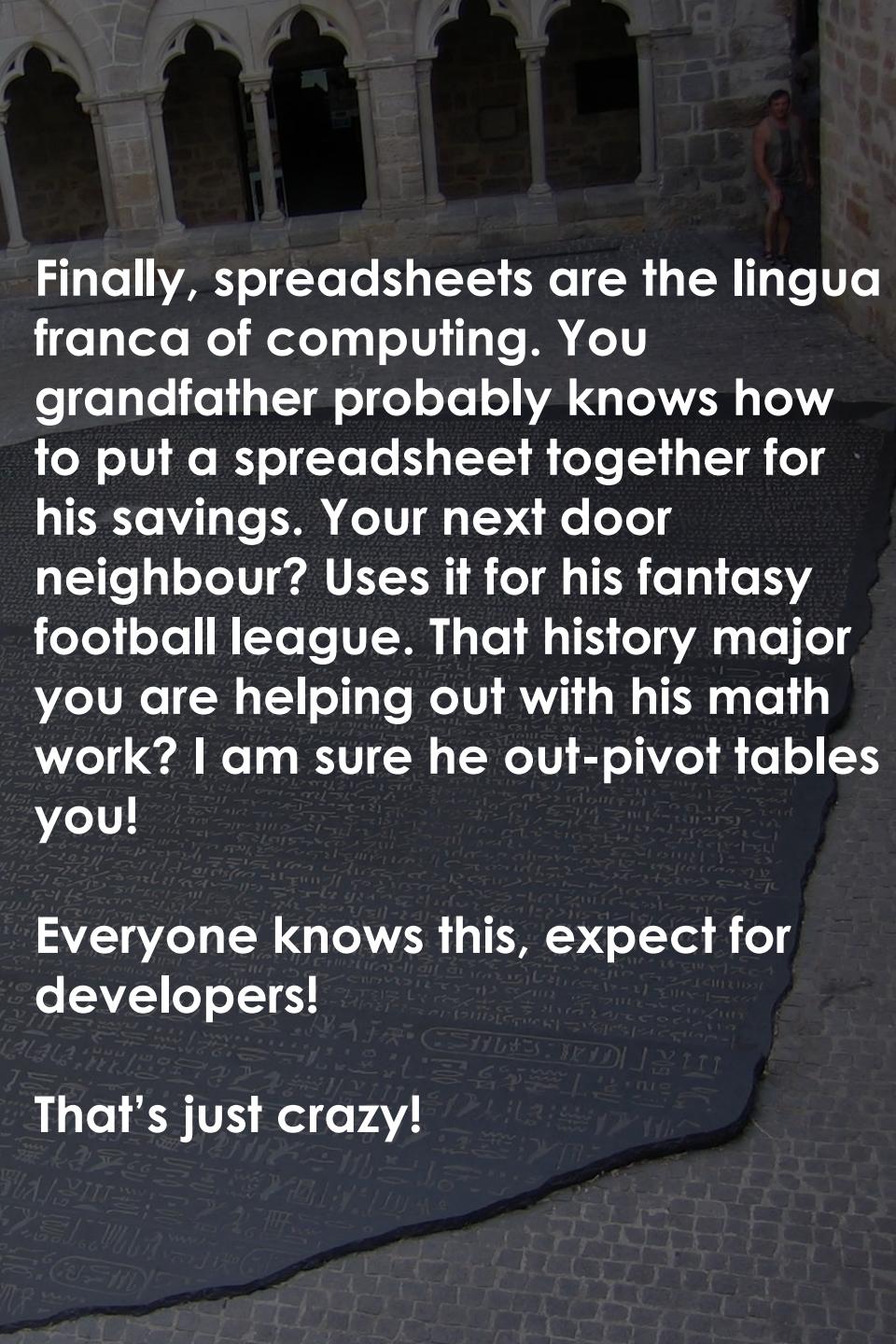
You love pure functional  
languages?

We've got you covered. All a  
formula can do is take input and  
do something with it.

No side effects possible.



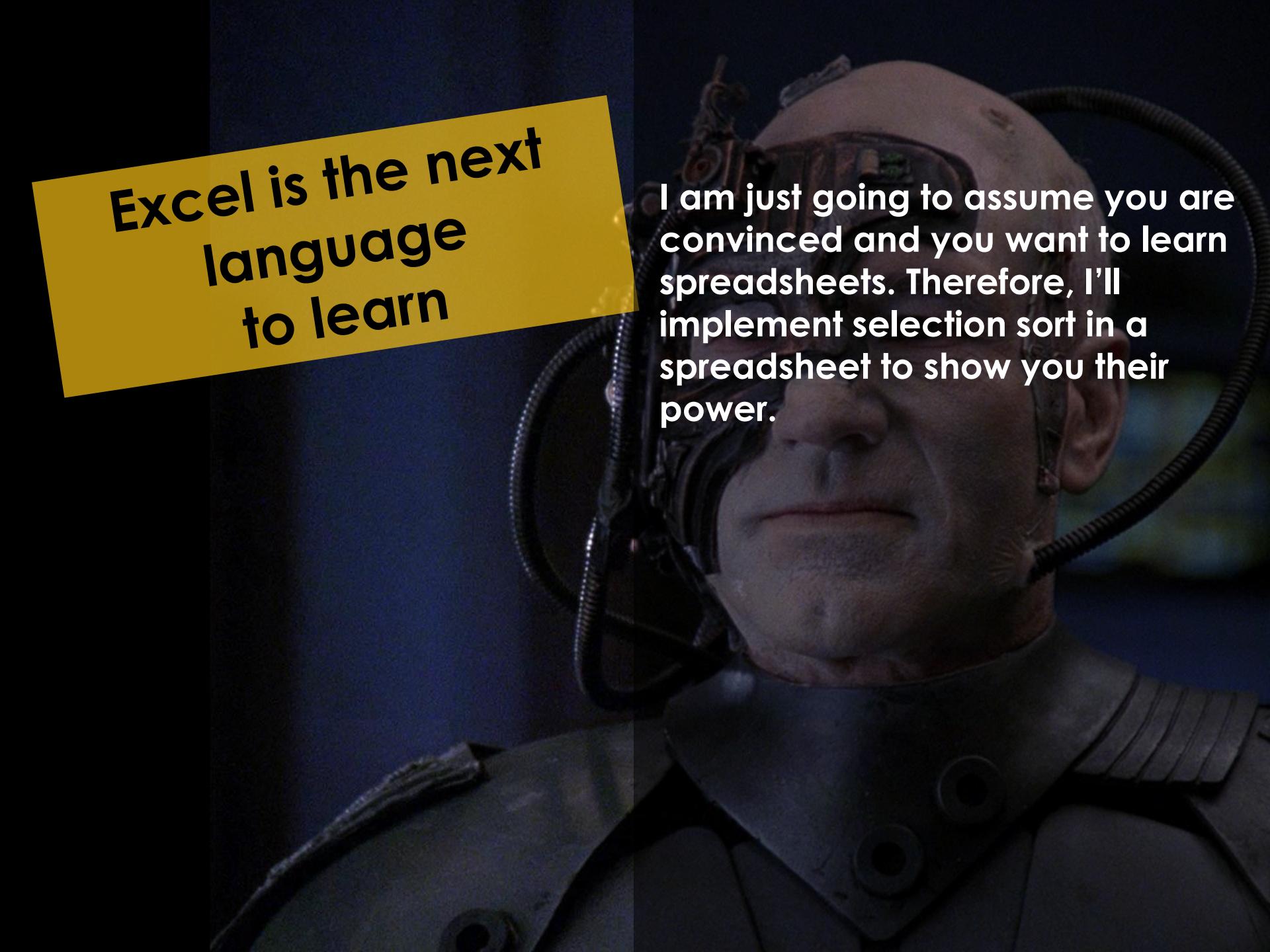
**Lingua franca  
of computing**



Finally, spreadsheets are the lingua franca of computing. You grandfather probably knows how to put a spreadsheet together for his savings. Your next door neighbour? Uses it for his fantasy football league. That history major you are helping out with his math work? I am sure he out-pivot tables you!

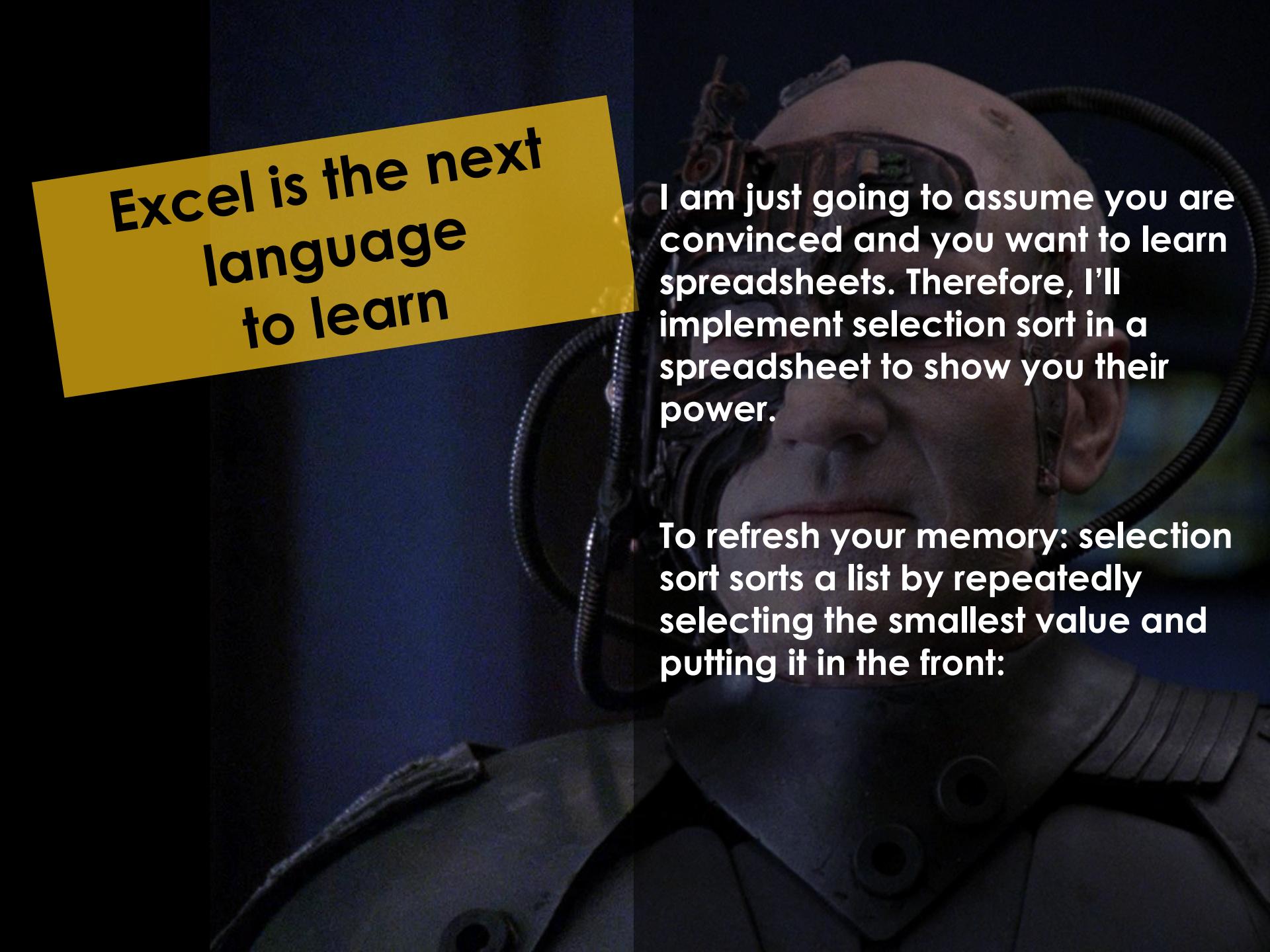
**Everyone knows this, except for  
developers!**

**That's just crazy!**



**Excel is the next  
language  
to learn**

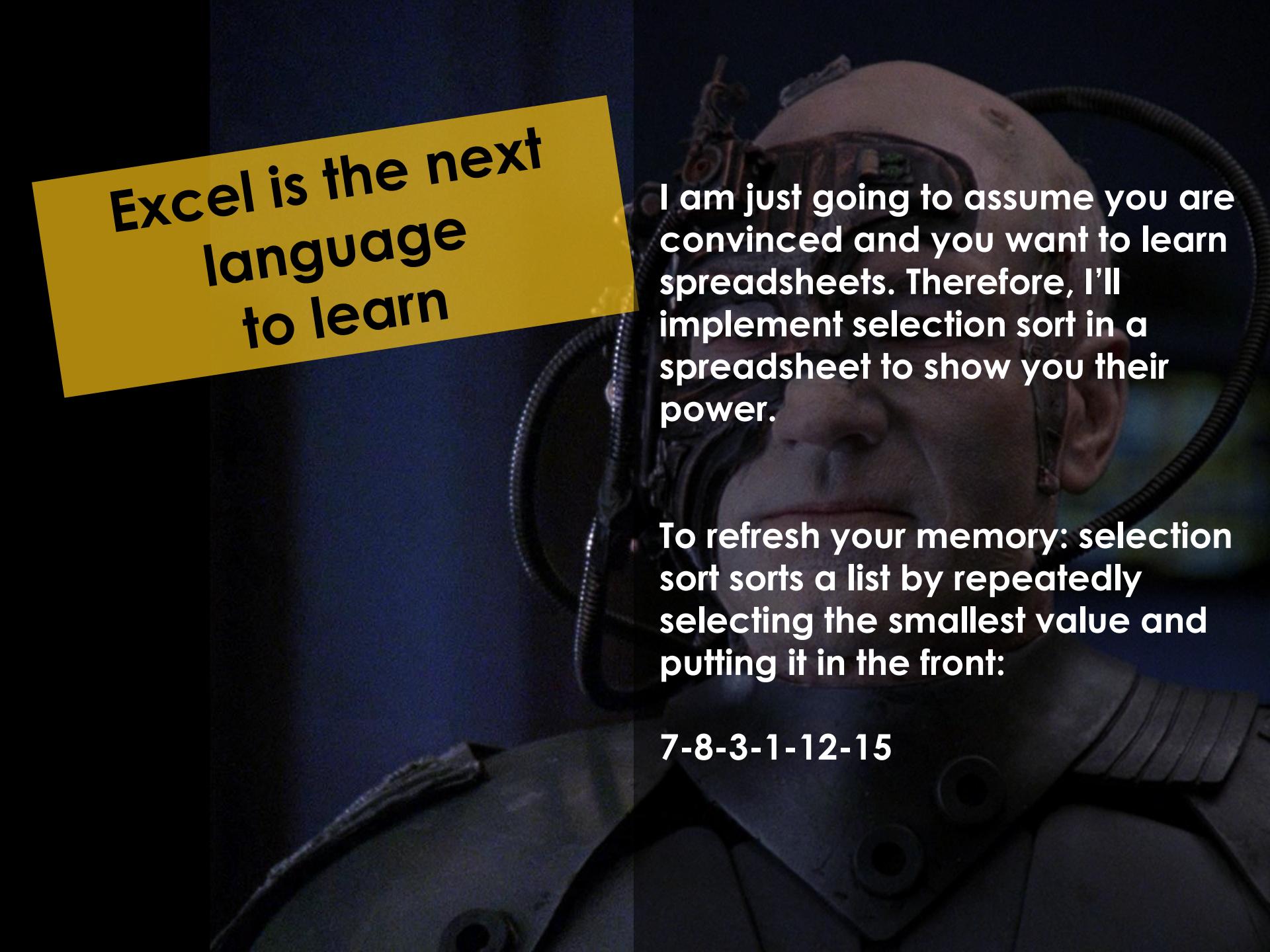
I am just going to assume you are convinced and you want to learn spreadsheets. Therefore, I'll implement selection sort in a spreadsheet to show you their power.



**Excel is the next  
language  
to learn**

I am just going to assume you are convinced and you want to learn spreadsheets. Therefore, I'll implement selection sort in a spreadsheet to show you their power.

To refresh your memory: selection sort sorts a list by repeatedly selecting the smallest value and putting it in the front:

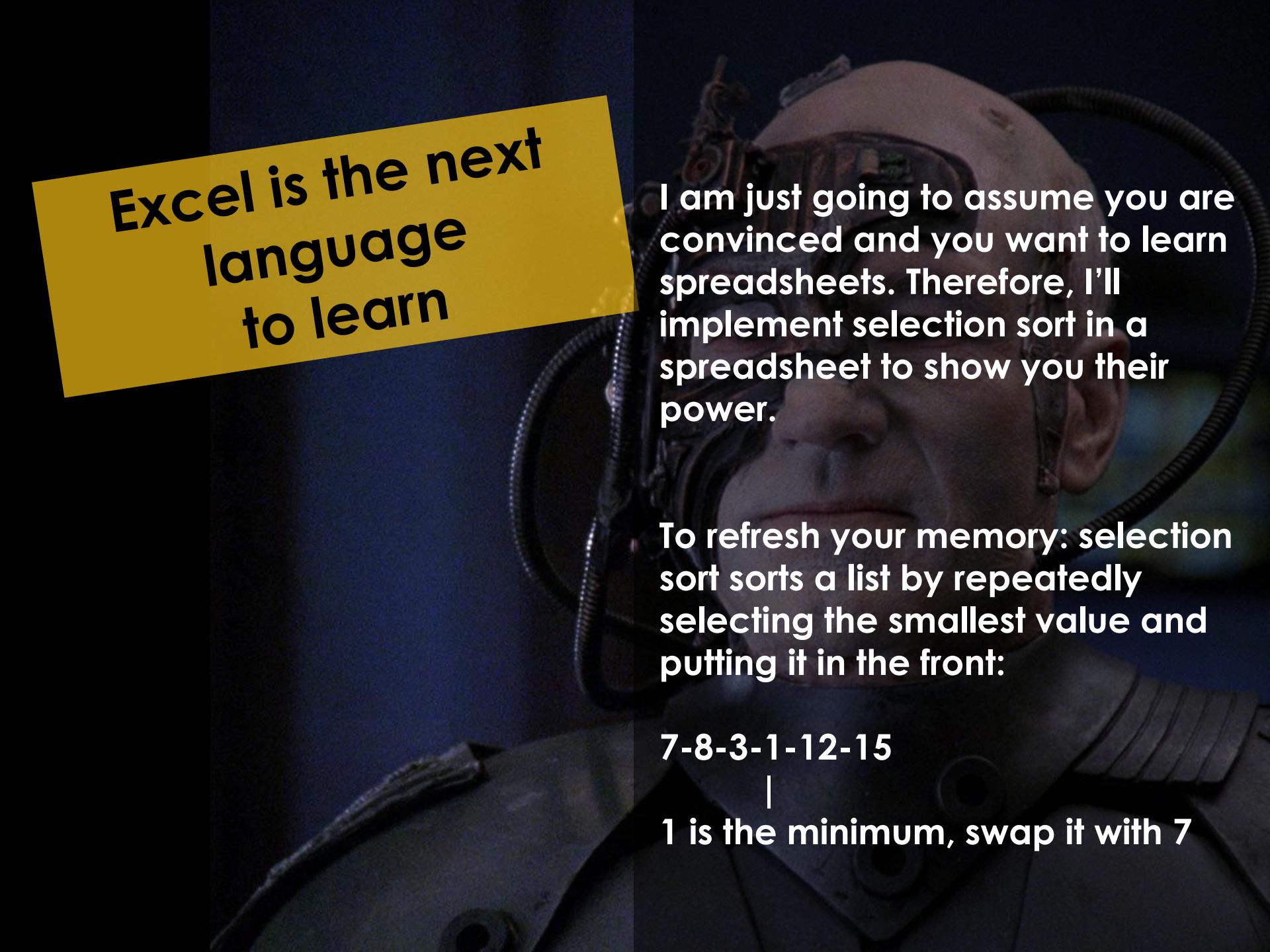


**Excel is the next  
language  
to learn**

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To refresh your memory: selection sort sorts a list by repeatedly selecting the smallest value and putting it in the front:

7-8-3-1-12-15



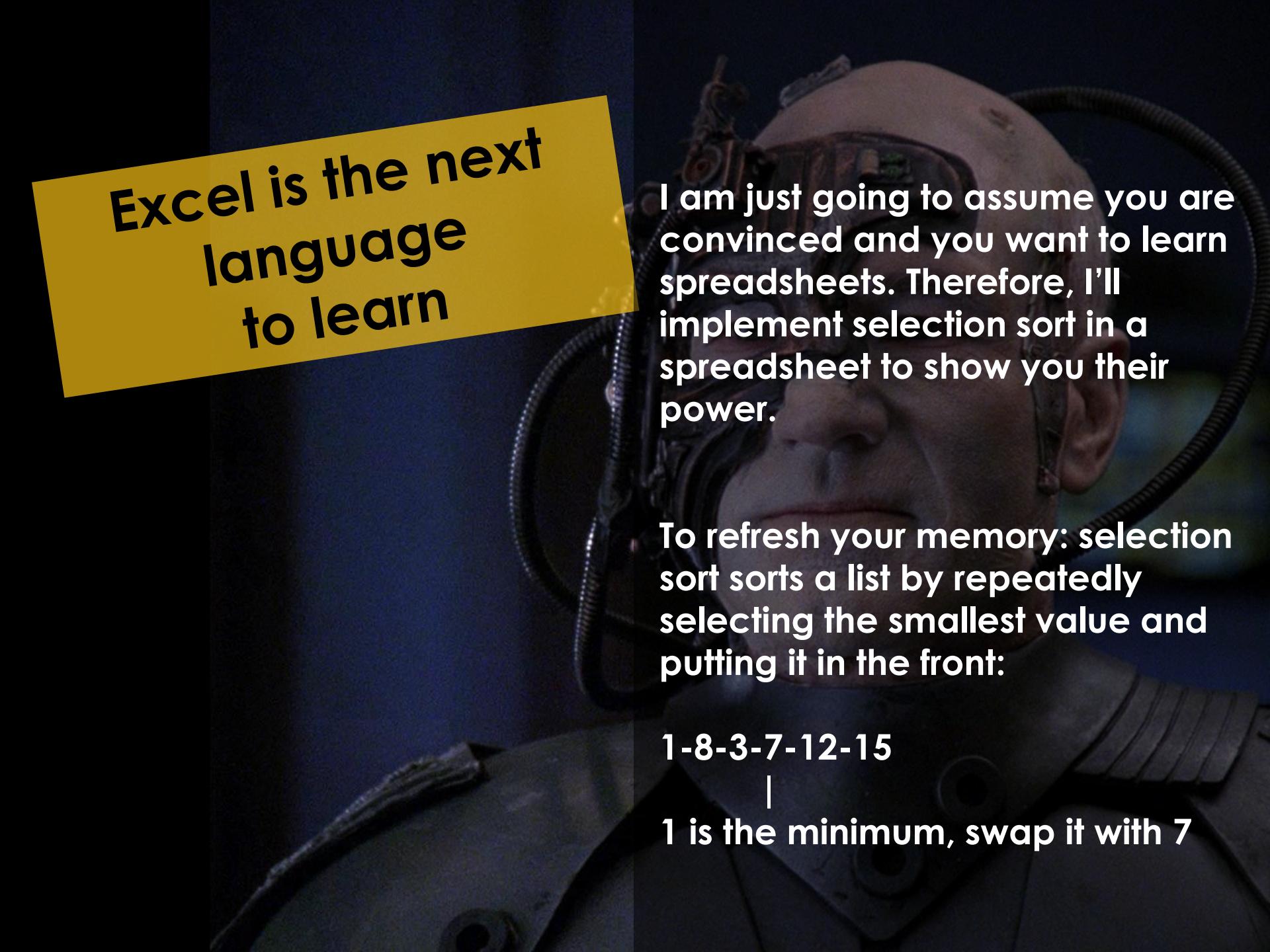
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I am just going to assume you are convinced and you want to learn spreadsheets. Therefore, I'll implement selection sort in a spreadsheet to show you their power.

To refresh your memory: selection sort sorts a list by repeatedly selecting the smallest value and putting it in the front:

7-8-3-1-12-15  
|

1 is the minimum, swap it with 7



**Excel is the next  
language  
to learn**

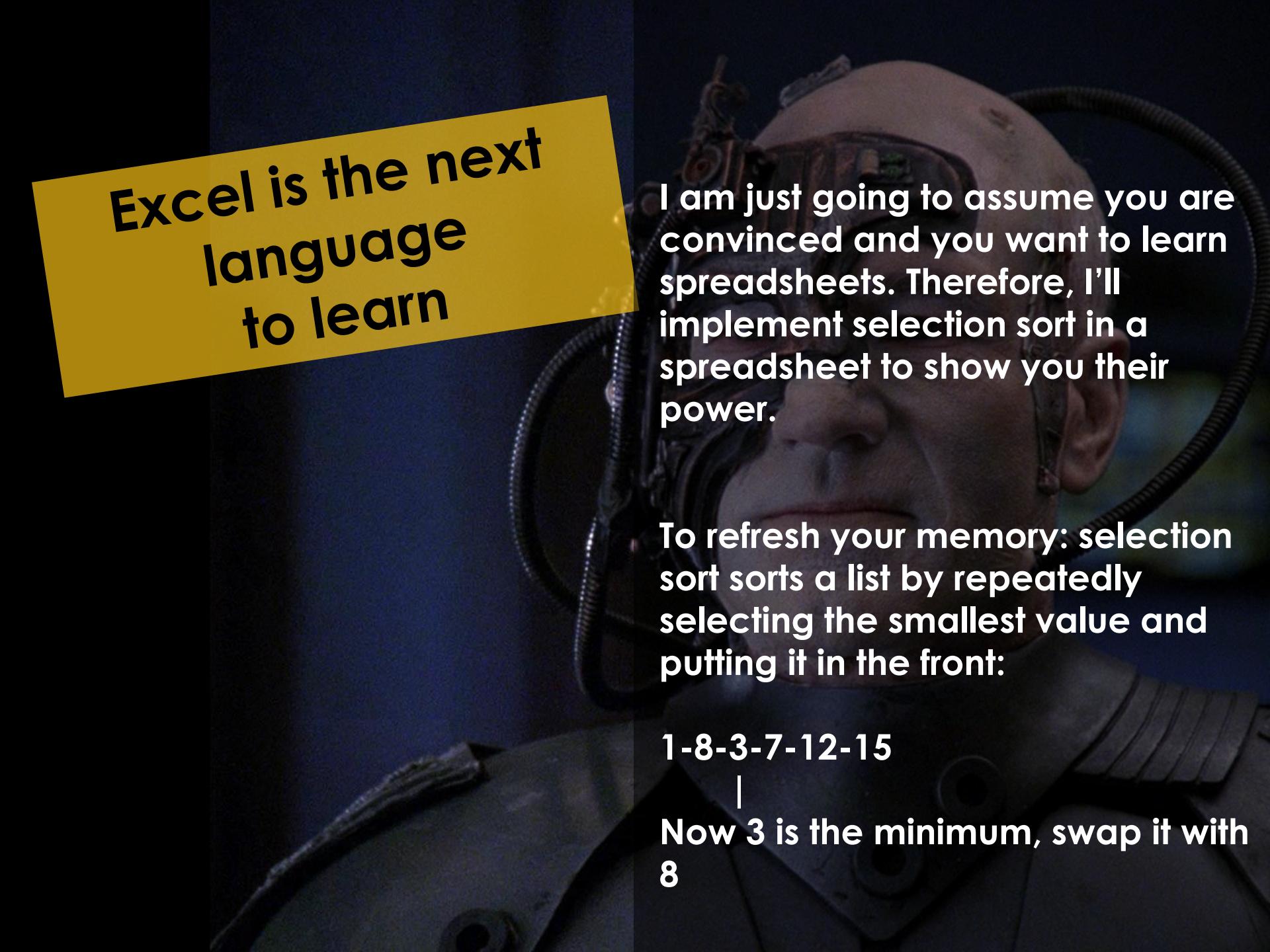
I am just going to assume you are convinced and you want to learn spreadsheets. Therefore, I'll implement selection sort in a spreadsheet to show you their power.

To refresh your memory: selection sort sorts a list by repeatedly selecting the smallest value and putting it in the front:

1-8-3-7-12-15

|

1 is the minimum, swap it with 7



**Excel is the next  
language  
to learn**

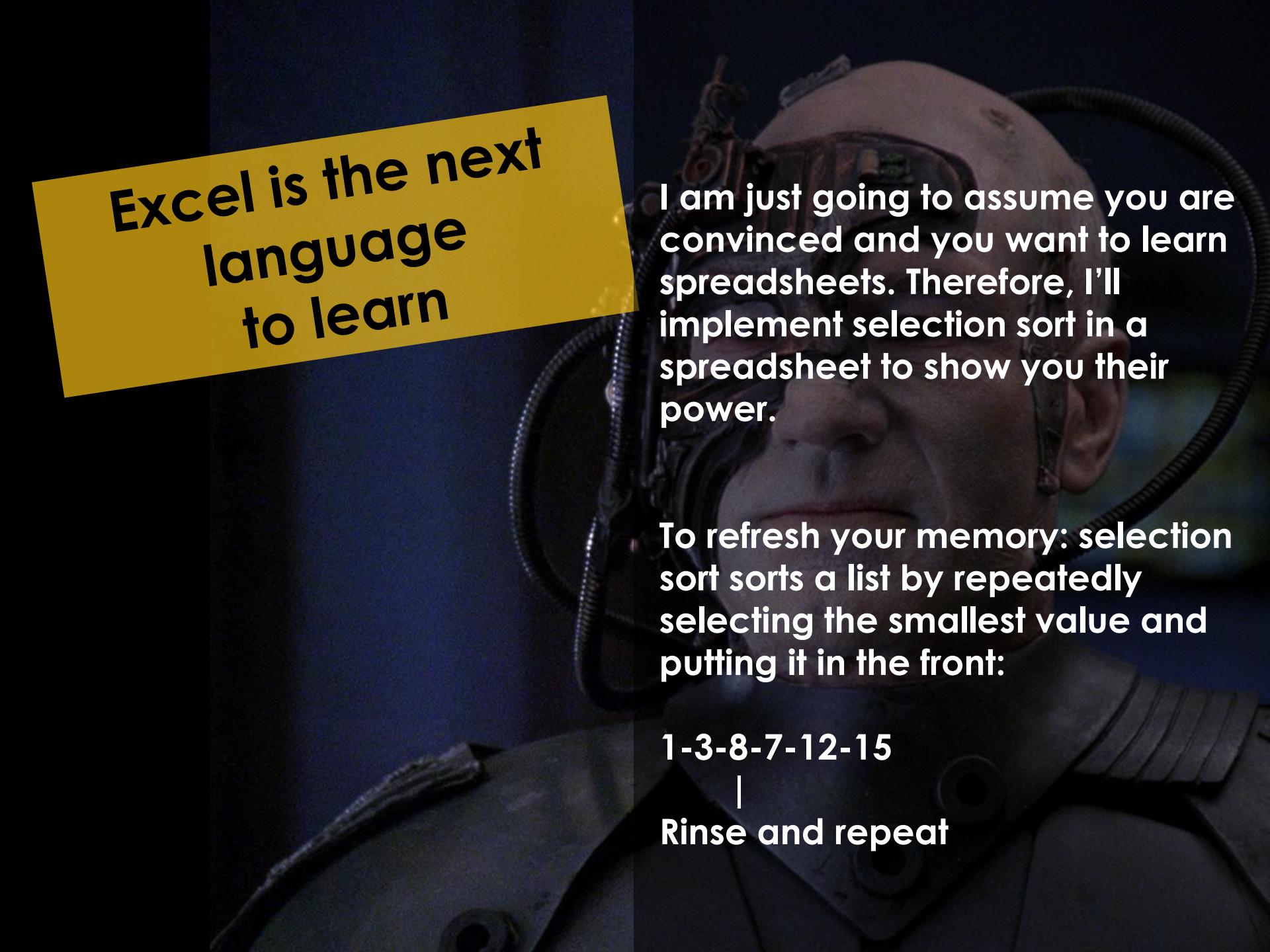
I am just going to assume you are convinced and you want to learn spreadsheets. Therefore, I'll implement selection sort in a spreadsheet to show you their power.

To refresh your memory: selection sort sorts a list by repeatedly selecting the smallest value and putting it in the front:

1-8-3-7-12-15

|

Now 3 is the minimum, swap it with 8



**Excel is the next  
language  
to learn**

I am just going to assume you are convinced and you want to learn spreadsheets. Therefore, I'll implement selection sort in a spreadsheet to show you their power.

To refresh your memory: selection sort sorts a list by repeatedly selecting the smallest value and putting it in the front:

1-3-8-7-12-15  
|

Rinse and repeat

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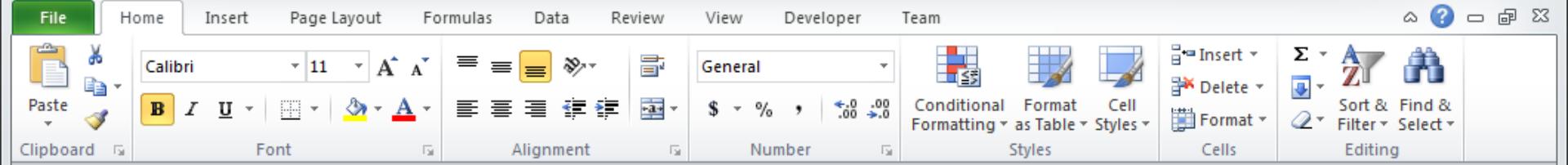
E3 13

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1																		
2																		
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4																		
5																		
6																		
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What we want to sort

Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9 Step10 Step11 Step12 Step13 Step14 Step15 Step16 Step17 Step18 Step19

Ready



E2

1

# The index

1	2	3	4	5	6	7	8	9	10	11	12	13
13	5	3	10	14	4	8	11	7	1	9	6	12

The first formulas is  
obvious:  
find the minimum

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SUM =MIN(3:3)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1			Min															
2				1	2	3	4	5	6	7	8	9	10	11	12	13		
3				13	5	3	10	14	4	8	11	7	1	9	6	12		
4			=MIN()															
5																		
6																		
7																		
8																		
9																		
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11																		
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17																		
18																		
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Little known fact: you could also use 3:3 here, to indicate the 3rd row  
(much like the more known A:A for the A column)



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SUM

`=MATCH(C4,E3:Q3,0)`

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1			Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4					1	=MATCH(C4,E3:Q3,0)												
5																		
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Next is finding the location of the minimum, we can do that with MATCH

MATCH takes as arguments: the search value, the range to search in and the type of match (exact or bigger/smaller)

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SUM

 $=\text{MATCH}(\text{C4}, \text{E3:Q3}, 0)$ 

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1			Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4					1	10												
5																		
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**MATCH results in 10:  
the minimum is  
found on index 10**

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SUM  $=IF(E2=D4,"X","_")$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1				Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13
2						13												
3						5	3	10	14	4	8	11	7	1	9	6	12	
4						10	=IF(E											
5																		
6																		
7																		
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Let's start small and make a formula that places an "X" in the swap spots

Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9 Step10

Edit

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**SUM**  $=IF(E2=D4,"X","_")$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1			Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2																		
3																		
4					13	5	3	10	14	4	8	11	7	1	9	6	12	
5					10	=IF(E												
6																		
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10																		
11																		
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13																		
14																		
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19																		

**So: if our index is equal to the index of the minimum, we swap (X) otherwise we do nothing (\_)**

**Let's start small and make a formula that places an "X" in the swap spots**

Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9 Step10

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SUM fx =IF(E2=D4,"X","\_")

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1				Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13
2						13												
3						5	3	10	14	4	8	11	7	1	9	6	12	
4					10	=IF(E												
5																		
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8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
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17																		
18																		
19																		

That looks cool,  
let's drag it right

So: if our index is  
equal to the index  
of the minimum,  
we swap (X)  
otherwise we do  
nothing (\_)

Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9 Step10 Step11 Step12 Step13 Step14 Step15 Step16 Step17 Step18 Step19

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E4 =IF(E2=D4,"X","\_")

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1			Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4			1	10	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	
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Aww... Something went wrong!

Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9 Step10 Step11 Step12 Step13 Step14 Step15 Step16 Step17 Step18 Step19

Count: 13 140%

SUM    =IF(N2=M4,"X","\_")

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1			Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4					1	10	_	_	_	_	_	_	_	=IF(N				
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17																		
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19																		

By default, Excel transforms formulas by location, so this one is changed incorrectly

SUM    =IF(E2=\$D4,"X","\_")

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1				Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13
2						13	5	3	10	14	4	8	11	7	1	9	6	12
3						13	5	3	10	14	4	8	11	7	1	9	6	12
4						10	=IF(E											
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If we do not want that, we add a \$ before a reference to fix it. Now, only the row is updated

The screenshot shows the Microsoft Excel ribbon at the top with tabs like File, Home, Insert, Page Layout, Formulas, Data, Review, View, Developer, and Team. The Home tab is selected. Below the ribbon is the formula bar with the formula '=IF(E2=\$D4,"X","\_")'. The main workspace shows a table of numbers from 1 to 13. Cell E4 contains the formula. A green box highlights the range D4:D5, and a blue box highlights the range E2:E4. A yellow callout bubble points to the '\$' sign in the formula.

SUM

 $=IF(E2=\$D4,"X","_")$ 

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1			Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3					10	=IF(E												
4																		
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Let's try dragging again

If we do not want  
that, we add a \$  
before a reference  
to fix it. Now, only  
the row is updated

SUM    =IF(N2=\$D4,"X","\_")

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1			Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4					1	10	_	_	_	_	_	_	_	X	_	_	_	
5																		
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It works!

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SUM =IF(N\$2=\$D4,"X","\_")

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1			Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4			1	10	_	-	-	-	-	-	-	-	-	X	-	-	-	
5																		
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Let's also fix the index row here, because we are dragging all this down later

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B I U Alignment Conditional Formatting as Table Format Styles

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Σ A Z Sort & Filter Find & Select Editing

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4		1		10	-	-	-	-	-	-	-	-	X	-	-	-	-	
5																		
6																		
7																		
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9																		
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12																		
13																		
14																		
15																		
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17																		
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19																		

We will swap based on the index, starting at 1

Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9 SI

Ready

SUM  $\rightarrow$   $=\text{INDEX}(E3:Q3,1,B4)$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	=INDEX		1	1	10	-	-	-	-	-	-	-	-	X	-	-	-	
5																		
6																		
7																		
8																		
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We also swap the value, which we can find with INDEX

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**Σ** Insert Delete Format Cell Styles Format Cells

Sort & Filter Find & Select Editing

SUM

`=INDEX(E3:Q3,1,B4)`

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1 Swap	IndexSwap	Min	IndexMin														
2				1	2	3	4	5	6	7	8	9	10	11	12	13	
3				13	5	3	10	14	4	8	11	7	1	9	6	12	
4	=INDEX		1	1	10	-	-	-	-	-	-	-	X	-	-	-	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	

We also the swap value, which we can find with INDEX

**INDEX takes as arguments: the range to locate a value in, followed by the row and column**

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Sort & Filter Find & Select Editing

SUM

`=INDEX(E3:Q3,1,B4)`

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	<code>=INDEX</code>	1	1	10	-	-	-	-	-	-	-	-	X	-	-	-	-	
5																		
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We also the swap value, which we can find with INDEX

We use row 1 (as we are looking in only one row) and the column in B4 (the index of the swap)

INDEX takes as arguments: the range to locate a value in, followed by the row and column

The screenshot shows the Microsoft Excel ribbon with the 'Home' tab selected. The formula bar displays the formula `=IF(E$2=$D4,"X","_")`. The worksheet contains the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13													
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13		1	1	10	" "								X				
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
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18																		
19																		

A yellow callout box is overlaid on the worksheet, containing the text: "With this, we can edit the second branch of the if, to add the second swap situation".

With this, we can  
edit the second  
branch of the if, to  
add the second  
swap situation

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SUM

 $=IF(E$2=\$D4,"X",IF(E$2=\$B4,"X","_"))$ 

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13	1	1	10	=IF(E									X				
5																		
6																		
7																		
8																		
9																		
10																		
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14																		
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With this, we can edit the second branch of the if, to add the second swap situation

We also swap is the index is equal to the 'swap index'

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E4 =IF(E\$2=\$D4,"X",IF(E\$2=\$B4,"X","\_"))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13		1	1	10	X								X				
5																		
6																		
7																		
8																		
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10																		
11																		
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19																		

Works!  
We marked both  
swap spots with an X

Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9 Step10 Step11

Ready

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**Σ** Insert Delete Format Cell Styles Format Cells

Sort & Filter Find & Select Editing

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3					13	1	10	=IF(E						X				
4	13	1	1	10	=IF(E													
5																		
6																		
7																		
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10																		
11																		
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Let's fill in the easiest blank first, the \_. In case we do not swap, we can just use the value above.

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E4 =IF(E\$2=\$D4,"X",IF(E\$2=\$B4,"X",E3))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3					10	X	5	3	10	14	4	8	11	7	X	9	6	12
4	13		1	1														
5																		
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Let's fill in the easiest blank first, the \_  
In case we do not swap, we can just use the value above

SelectionSort.xlsx - Microsoft Excel

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Paste Clipboard Font Alignment Number Conditional Formatting as Table Format Cell Styles Cells Sort & Filter Find & Select Editing

E3 13

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	6	7	9	8	11	14	1	4	10	12	
4	13		1	1	10 X	5	3	6	7	9	8	11	14	X	4	10	12	
5																		
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7																		
8																		
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11																		
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13																		
14																		
15																		
16																		
17																		
18																		
19																		

Conditional Formatting Rules Manager

Show formatting rules for: Current Selection

New Rule... Edit Rule... Delete Rule

Rule (applied in order shown)	Format	Applies to	Stop If True
Formula: =E3=\$A4	AaBbCcYv	=E\$3:\$Q\$4	<input type="checkbox"/>
Formula: =E3=\$C4	AaBbCcYv	=E\$3:\$Q\$4	<input type="checkbox"/>

OK Close Apply

Before we go any further, I added conditional formatting to indicate the swap spots

Step6 Step7 Step8 Step9 Step10 Step11 Step12 Step13 Step14 Step15 Step16 Step17 Step18 Step19

Ready

140%

File Home Insert Page Layout Formulas Data Review View Developer Team

Paste **Clipboard** Font Alignment Number Conditional Formatting as Table Styles Cells

**Σ** Insert Delete Format Cell Format Cells

Sort & Filter Find & Select Editing

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2																		
3					13	5	3	6	7	9	8	11	14	1	4	10	12	
4	13	1	1	10	=IF(E	5	3	6	7	9	8	11	14	X	4	10	12	
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		

So what goes on this spot? If the index is equal to the swap spot...

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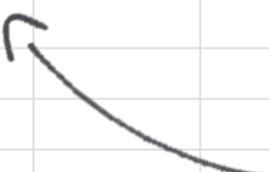
Paste **Clipboard** Font Alignment Number Conditional Formatting as Table Format Styles Cells Cells Sort & Filter Find & Select Editing

SUM

 $=IF(E$2=\$D4,"X",IF(E$2=\$B4,\$C4,E3))$ 

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	6	7	9	8	11	14	1	4	10	12	
4	13	1	1	10	=IF(E	5	3	6	7	9	8	11	14	X	4	10	12	
5																		
6																		
7																		
8																		
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10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		

So what goes on this spot? If the index is equal to the swap spot, we output the minimum



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Paste **Clipboard** Font Alignment Number Conditional Formatting as Table Styles Cells

**Σ** Insert Delete Format Cell Styles Format Cells

Sort & Filter Find & Select Editing

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13													
3					13	5	3	6	7	9	8	11	14	1	4	10	12	
4	13		1	1	10	=IF(E	5	3	6	7	9	8	11	14	X	4	10	12
5																		
6																		
7																		
8																		
9																		
10	<b>And if the index is swap, we output the swap value</b>																	
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		

File Home Insert Page Layout Formulas Data Review View Developer Team

Paste **Clipboard** Font Alignment Number Conditional Formatting as Table Styles Cells

Σ **A-Z** Find & Select Editing

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	6	7	9	8	11	14	1	4	10	12	
4	13		1	1	10	1	5	3	6	7	9	8	11	14	13	4	10	12
5																		
6																		
7																		
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12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		

**Swapped!**

Step6 Step7 Step8 Step9 Step10 Step11 Step12 Step13 Step14 Step15 Step16 Step17 Step18 Step19

Average: 7.923076923 Count: 13 Sum: 103

File Home Insert Page Layout Formulas Data Review View Developer Team

Calibri 11 A A General \$ % , .00 .00 Conditional Formatting as Table Format Styles Insert Delete Format Cells Sort & Filter Find & Select Editing

E4 =IF(E\$2=\$D4,\$A4,IF(E\$2=\$B4,\$C4,E3))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	6	7	9	8	11	14	1	4	10	12	
4	13		1	1	10	1	5	3	6	7	9	8	11	14	13	4	10	12
5																		
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7																		
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9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		

Swapped!

Looks like we are ready to draw all formulas down

Step6 Step7 Step8 Step9 Step10 Step11 Step12 Step13 Step14 Step15 Step16 Step17 Step18 Step19

Average: 7.923076923 Count: 13 Sum: 103 140%

File Home Insert Page Layout Formulas Data Review View Developer Team

Font Alignment Number Conditional Formatting as Table Format Styles Cells

Clipboard Font Alignment Number Conditional Formatting as Table Format Styles Cells

Cells

Σ A Z Find & Select Editing

A4

fx

=INDEX(E3:Q3,1,B4)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13	1	1	10	1	5	3	10	14	4	8	11	7	13	9	6	12	
5	5	2	1	1	5	1	3	10	14	4	8	11	7	13	9	6	12	
6	3	3	1	2	5	3	1	10	14	4	8	11	7	13	9	6	12	
7	10	4	1	3	5	3	10	1	14	4	8	11	7	13	9	6	12	
8	14	5	1	4	5	3	10	14	1	4	8	11	7	13	9	6	12	
9	4	6	1	5	5	3	10	14	4	1	8	11	7	13	9	6	12	
10	8	7	1	6	5	3	10	14	4	8	1	11	7	13	9	6	12	
11	11	8	1	7	5	3	10	14	4	8	11	1	7	13	9	6	12	
12	7	9	1	8	5	3	10	14	4	8	11	7	1	13	9	6	12	
13	13	10	1	9	5	3	10	14	4	8	11	7	13	1	9	6	12	
14	9	11	1	10	5	3	10	14	4	8	11	7	13	9	1	6	12	
15	6	12	1	11	5	3	10	14	4	8	11	7	13	9	6	1	12	



File Home Insert Page Layout Formulas Data Review View Developer Team

Font Alignment Number Conditional Formatting as Table Format Styles Cells

Clipboard Font Alignment Number Conditional Formatting as Table Format Styles Cells

Cells

Σ A Z Find & Select Editing

A4

 $=INDEX(E3:Q3,1,B4)$ 

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13	1	1	10	1	5	3	10	14	4	8	11	7	1	9	6	12	
5	5	2	1	1	5	1	3	10	14	4	8	11	7	1	9	6	12	
6	3	3	1	2	5	3	1	10	14	4	8	11	7	1	9	6	12	
7	10	4	1	3	5	3	10	1	14	4	8	11	7	1	9	6	12	
8	14	5	1	4	5	3	10	14	1	4	8	11	7	1	9	6	12	
9	4	6	1	5	5	3	10	14	4	1	8	11	7	1	9	6	12	
10	8	7	1	6	5	3	10	14	4	8	1	11	7	13	9	6	12	
11	11	8	1	7	5	3	10	14	4	8	11	1	7	13	9	6	12	
12	7	9	1	8	5	3	10	14	4	8	11	7	1	13	9	6	12	
13	13	10	1	9	5	3	10	14	4	8	11	7	13	1	9	6	12	
14	9	11	1	10	5	3	10	14	4	8	11	7	13	9	1	6	12	
15	6	12	1	11	5	3	10	14	4	8	11	7	13	9	6	1	12	
16																		
17																		
18																		
19																		

Whoops!  
Something went  
wrong.  
Can you spot  
what?

SUM     $=\text{MIN}(E3:Q3)$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	
1	Swap	IndexSwap	Min	IndexMin															
2					1	2	3	4	5	6	7	8	9	10	11	12	13		
3					13	5	3	10	14	4	8	11	7	1	9	6	12		
4	13		1	=MIN	10	1	5	1	3	10	14	4	8	11	7	13	9	6	12
5	5		2	1	1	5	1	3	10	14	4	8	11	7	13	9	6	12	
6	3		3	1	2	5	3	1	10	14	4	8	11	7	13	9	6	12	
7	10		4	1	3	5	3	10	1	14	4	8	11	7	13	9	6	12	
8	14		5	1	4	5	3	10	14	1	4	8	11	7	13	9	6	12	
9	4		6	1	5	5	3	10	14	4	1	8	11	7	13	9	6	12	
10	8		7		10	14	4	8	1	11	7	13	9	6	12				
11	11		8		10	14	4	8	11	1	7	13	9	6	12				
12	7		9		10	14	4	8	11	7	1	13	9	6	12				
13	13		10		10	14	4	8	11	7	13	1	9	6	12				
14	9		11	1	10	5	3	10	14	4	8	11	7	13	9	1	6	12	
15	6		12	1	11	5	3	10	14	4	8	11	7	13	9	6	1	12	
16																			
17																			
18																			
19																			

1 is picked as minimum everywhere

File Home Insert Page Layout Formulas Data Review View Developer Team

Paste **Font** Alignment Number Conditional Formatting as Table Format Styles Cells

**Σ** Insert Delete Format Format Cells

Sort & Filter Find & Select Editing

**SUM**  $=\text{MIN}(E3:Q3)$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	
1	Swap	IndexSwap	Min	IndexMin															
2					1	2	3	4	5	6	7	8	9	10	11	12	13		
3					13	5	3	10	14	4	8	11	7	1	9	6	12		
4	13	1	=MIN		10	1	5	1	3	10	14	4	8	11	7	13	9	6	12
5	5	2	1		1	5	1	3	10	14	4	8	11	7	13	9	6	12	
6	3	3	1		2	5	3	1	10	14	4	8	11	7	13	9	6	12	
7	10	4	1		3	5	3	10	1	14	4	8	11	7	13	9	6	12	
8	14	5	1		4	5	3	10	14	1	4	8	11	7	13	9	6	12	
9	4	6	1		5	5	3	10	14	4	1								
10	8	7			10	14	4	8											
11	11	8			10	14	4	8	11	1	7	13	9						
12	7	9			10	14	4	8	11	7	1	13	9						
13	13	10			10	14	4	8	11	7	13	1	9						
14	9	11	1		10	5	3	10	14	4	8	11	7	13	9	1	6	12	
15	6	12	1		11	5	3	10	14	4	8	11	7	13	9	6	1	12	
16																			
17																			
18																			
19																			

Step7 Step8 Step9 Step10 Step11 Step12 Step13 Step14 Step15 All

Edit 140%

**1 is picked as minimum everywhere**

**This range needs to shift right every step**

File Home Insert Page Layout Formulas Data Review View Developer Team

Paste **Font** Alignment Number Conditional Formatting as Table Format Styles Cells

**Σ** Insert Delete Format Format Cells

Sort & Filter Find & Select Editing

SUM

`=MIN(OFFSET(E3:Q3,0,B4-1))`

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13		1	=MIN	10	1	5	3	10	14	4	8	11	7	13	9	6	12
5	5		2	1	1	5	1	3	10	14	4	8	11	7	13	9	6	12
6	3		3	1	2	5	3	1	10	14	4	8	11	7	13	9	6	12
7	10		4	1	3	5	3	10	1	14	4	8	11	7	13	9	6	12
8	14		5	1	4	5	3	10	14	1	4	8	11	7	13	9	6	12
9	4		6		14	4	1	8	11	7	13	9	6	12				
10	8		7		14	4	8	1	11	7	13	9	6	12				
11	11		8		14	4	8	11	1	7	13	9	6	12				
12	7		9		14	4	8	11	7	1	13	9	6	12				
13	13		10	1	9	5	3	10	14	4	8	11	7	13	1	9	6	12
14	9		11	1	10	5	3	10	14	4	8	11	7	13	9	1	6	12
15	6		12	1	11	5	3	10	14	4	8	11	7	13	9	6	1	12
16																		
17																		
18																		
19																		
	Step7	Step8	Step9	Step10	Step11	Step12	Step13	Step14	Step15	All								
Edit	Cells																	

We can use the  
OFFSET function  
for that

File Home Insert Page Layout Formulas Data Review View Developer Team

Paste **Clipboard** Font Alignment Number Conditional Formatting as Table Format Styles Cells

**Σ** Insert Delete Format Cell Styles Format Cells

Sort & Filter Find & Select Editing

SUM

`=MIN(OFFSET(E3:Q3,0,B4-1))`

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3	13		1	=MIN	10	1	5	1	3	10	14	4	8	11	7	13	9	6
4	5	2	1		1	5	1	3	10	14	4	8	11	7	13	9	6	12
5	3	3	1		2	5	3	1	10	14	4	8	11	7	13	9	6	12
6	10	4	1		3	5	3	10	1	14	4	8	11	7	13	9	6	12
7	14	5	1		4	5	3	10	14	1	14	4	8	11	7	13	9	6
8	4	6	1		1	1	1	1	1	1	14	4	8	11	7	13	9	6
9	8	7	1		1	1	1	1	1	1	14	4	8	11	7	13	9	6
10	11	8	1		1	1	1	1	1	1	14	4	8	11	7	13	9	6
11	7	9	1		1	1	1	1	1	1	14	4	8	11	7	13	9	6
12	13	10	1		9	5	3	10	14	4	8	11	7	13	1	9	6	12
13	9	11	1		10	5	3	10	14	4	8	11	7	13	9	1	6	12
14	6	12	1		11	5	3	10	14	4	8	11	7	13	9	6	1	12
15																		
16																		
17																		
18																		
19																		

We can use the  
OFFSET function  
for that

OFFSET takes as  
arguments: the range  
you want to shift,  
followed by number of  
rows and number of  
columns

File Home Insert Page Layout Formulas Data Review View Developer Team

Paste **Clipboard** Font Alignment Number Conditional Formatting as Table Format Styles Cells

**Σ** Insert Delete Format Cell Styles Format Cells

Sort & Filter Find & Select Editing

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	
1	Swap	IndexSwap	Min	IndexMin															
2					1	2	3	4	5	6	7	8	9	10	11	12	13		
3					13	5	3	10	14	4	8	11	7	1	9	6	12		
4	13		1	=MIN	10	1	5	1	3	10	14	4	8	11	7	13	9	6	12
5	5		2	1	1	5	1	3	10	14	4	8	11	7	13	9	6	12	
6	3		3	1	2	5	3	1	10	14	4	8	11	7	13	9	6	12	
7	10		4	1	3	5	3	10	1	14	4	8	11	7	13	9	6	12	
8	14		5	1	4	5	3	10	14	1	14	4	8	11	7	13	9	6	12
9	4		6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	12	
10	8		7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	12	
11	11		8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	12	
12	7		9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	12	
13	13		10	1	9	5	10	11	4	8	11	7	13	1	9	6	12		
14	9		11	1	10	5	3	10	14	7	13	9	1	6	12				
15	6		12	1	11	5	3	10	14	7	13	9	6	1	12				
16																			
17																			
18																			
19																			

We can use the  
OFFSET function  
for that

We'll shift no rows  
down and B4  
(swapindex)-1 left

OFFSET takes as  
arguments: the range  
you want to shift,  
followed by number of  
rows and number of  
columns

=MIN(OFFSET(E3:Q3,0,B4-1))

File Home Insert Page Layout Formulas Data Review View Developer Team

Font Alignment Number Conditional Formatting as Table Format Styles Cells

Clipboard Font Alignment Number Conditional Formatting as Table Format Styles Cells

Cells

Σ A Z Find & Select Editing

C4

 $=\text{MIN}(\text{OFFSET}(\text{E3:Q3},0,\text{B4}-1))$ 

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	10	11	12	13	
4	13		1	1	10	1	5	3	10	14	4	8	11	7	13	9	6	
5	5		2	3	3	1	3	5	10	14	4	8	11	7	13	9	6	
6	5		3	4	6	1	3	4	10	14	5	8	11	7	13	9	6	
7	10		4	5	6	1	3	4	5	14	10	8	11	7	13	9	6	
8	14		5	6	12	1	3	4	5	6	10	8	11	7	13	9	14	
9	10		6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	
10	8		7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	
11	11		8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	
12	10		9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	
13	13		10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	
14	13		11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	
15	14		12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	
16																		
17																		
18																		
19																		

Works!



But let's make  
things a bit scarier

**PopQuiz!**  
**What does  
this mean?**

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Q			
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					3	13	5	3	10	14	4	8	11	7	1	9	6	12
4	13		1	1	10	1	5	3	10	14	4	8	11	7	13	9	6	12
5	5		2	3	3	1	3	5	10	14	4	8	11	7	13	9	6	12
6	5		3	4	6	1	3	4	10	14	5	8	11	7	13	9	6	12
7	10		4	5	6	1	3	4	5	14	10	8	11	7	13	9	6	12
8	14		5	6	12	1	3	4	5	6	10	8	11	7	13	9	14	12
9	10		6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	12
10	8		7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	12
11	11		8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12
12	10		9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12
13	13		10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12
14	13		11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13
15	14		12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14
16																		
17																		
18																		

Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3

SelectionSort.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Developer Team

fx **Σ AutoSum** Logical Lookup & Reference Define Name Trace Precedents  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents  
Financial Date & Time More Functions Create from Selection Remove Arrows  
Function Library

SUM =A5:Q5 C1:C15

Swap IndexSwap Min IndexMin

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Q			
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					=A5:Q5 C1	13	5	3	10	14	4	8	11	7	1	9	6	12
4	13		1	1	10	1	5	3	10	14	4	8	11	7	13	9	6	12
5	5	2	3		3	1	3	5	10	14	4	8	11	7	13	9	6	12
6	5	3	4		6	1	3	4	10	14	5	8	11	7	13	9	6	12
7	10	4	5		6	1	3	4	5	14	10	8	11	7	13	9	6	12
8	14	5	6		12	1	3	4	5	6	10	8	11	7	13	9	14	12
9	10	6	7		9	1	3	4	5	6	7	8	11	10	13	9	14	12
10	8	7	8		4	5	6	7	8	11	10	13	9	14	12			
11	11	8	9		4	5	6	7	8	9	10	13	11	14	12			
12	10	9	10		1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11		11	1	3	4	5	6	7	8	9	10	11	13	14	12
14	13	11	12		13	1	3	4	5	6	7	8	9	10	11	12	14	13
15	14	12	13		13	1	3	4	5	6	7	8	9	10	11	12	13	14
16																		
17																		
18																		

Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3

Let me give you a hint

PopQuiz! What does this mean?

File Home Insert Page Layout Formulas Data Review View Developer Team

**fx** **Σ** AutoSum **Logical** **Lookup & Reference** **Name Manager** **Define Name** **Trace Precedents** **Show Formulas**  
**Insert Function** **Recently Used** **Text** **Math & Trig** **Use in Formula** **Trace Dependents** **Error Checking**  
**Financial** **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
**Function Library** **Defined Names** **Formula Auditing**

Watch Window Calculation Options Calculation

SUM

=A5:Q5 C1:C15

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					=A5:Q5 C1	13	5	3	10	14	4	8	11	7	1	9	6	12
4	13		1	1	10	1	5	3	10	14								12
5	5		2	3		3	1	3	5	10	14							12
6	5		3	4		6	1	3	4	10	14							12
7	10		4	5		6	1	3	4	5	14							12
8	14		5	6		12	1	3	4	5	6							12
9	10		6	7		9	1	3	4	5	6							12
10	8		7	8		4	5	6	7	8	9	10	11	12	13	14	15	
11	11		8	9		4	5	6	7	8	9	10	11	12	13	14	15	
12	10		9	10		1	3	4	5	6	7	8	9	10	11	12	13	
13	13		10	11		11	1	3	4	5	6	7	8	9	10	11	12	
14	13		11	12		13	1	3	4	5	6	7	8	9	10	11	12	
15	14		12	13		13	1	3	4	5	6	7	8	9	10	11	12	
16																		
17																		
18																		

= Range1 Range2

results in a reference to  
the intersection of the  
two ranges. In this  
case C5 with value 3.

Let me give  
you a hint

File Home Insert Page Layout Formulas Data Review View Developer Team

**Insert Function**

**AutoSum** **Logical** **Lookup & Reference** **Define Name** **Trace Precedents** **Show Formulas**  
**Recently Used** **Text** **Math & Trig** **Name Manager** **Use in Formula** **Trace Dependents** **Error Checking**  
**Financial** **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
**Function Library** **Defined Names** **Formula Auditing**

**Watch Window** **Calculation Options** **Calculation**

D3



=A5:Q5 C1:C15

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					3	13	5	3	10	14	4	8	11	7	1	9	6	
4	13		1	1	10	1	5	3	10	14	7	11	12	13	14	15	16	
5	5		2	3	3	1	3	5	10	14	8	11	12	13	14	15	16	
6	5		3	4	6	1	3	4	10	14	9	12	13	14	15	16	17	
7	10		4	5	6	1	3	4	5	14	10	13	11	12	13	14	15	
8	14		5	6	12	1	3	4	5	6	7	8	9	10	11	12	13	
9	10		6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	
10	8		7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	
11	11		8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	
12	10		9	10	9	1	3	4	5	6	7	8	9	10	13	11	12	
13	13		10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	
14	13		11	12	13	1	3	4	5	6	7	8	9	10	11	12	13	
15	14		12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	
16																		
17																		
18																		

= Range1 Range2  
 results in a reference to  
 the intersection of the  
 two ranges. In this  
 case C5 with value 3.

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File Home Insert Page Layout Formulas Data Review View Developer Team

fx **Σ AutoSum** Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library

Watch Window Calculation Options Calculation

SUM   fx =Index

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3					10	1	5	3	10	14	4	8	11	7	13	9	6	12
4	13	1	1		3	1	3	5	10	14	4	8	11	7	13	9	6	12
5	5	2	3		3	1	3	5	10	14	4	8	11	7	13	9	6	12
6	5	3	4		6	1	3	4	10	14	5	8	11	7	13	9	6	12
7	10	6	5		1	3	4	5	14	10	8	11	7	13	9	6	12	
8	14	5	6		3	4	5	6	10	8	11	7	13	9	14	12		
9	10	6	7		3	4	5	6	7	8	11	10	13	9	14	12		
10	8	6	7		3	4	5	6	7	8	11	10	13	9	14	12		
11	11	7	8		3	4	5	6	7	8	9	10	13	11	14	12		
12	10	8	9		3	4	5	6	7	8	9	10	13	11	14	12		
13	13	9	10		3	4	5	6	7	8	9	10	11	13	14	12		
14	13	11	12		13	1	3	4	5	6	7	8	9	10	11	12	13	14
15	14	12	13		13	1	3	4	5	6	7	8	9	10	11	12	13	14
16																		
17																		
18																		

Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4

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SelectionSort.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Developer Team

fx **Σ AutoSum** Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Watch Window Calculation Options Calculation

SUM =IF(E\$2=\$D4,\$A4,IF(E\$2=\$B4,\$C4,E3))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3					13	1	10	=IF(E	5	3	10	14	4	8	11	7	13	
4	13	1	1	10	13	5	3	10	14	4	8	11	7	13	9	6	12	
5	5	2	3	3	1	3	5	10	14	4	8	11	7	13	9	6	12	
6	5	3	4	6	1	3	10	14	5	8	11	7	13	9	6	12		
7	10	4	5	6	1	3	10	14	10	8	11	7	13	9	6	12		
8	14	5	6	12	4	5	6	10	8	11	7	13	9	6	12			
9	10	6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	12	
10	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	12	
11	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12	
14	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
15	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
16																		
17																		
18																		

Step10 Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3

With that, this becomes...

SelectionSort.xlsx - Microsoft Excel

**File** **Home** **Insert** **Page Layout** **Formulas** **Data** **Review** **View** **Developer** **Team**

**fx** **AutoSum** **Logical** **Lookup & Reference** **Define Name** **Trace Precedents** **Show Formulas**  
**Recently Used** **Text** **Math & Trig** **Name Manager** **Use in Formula** **Trace Dependents** **Error Checking**  
**Insert Function** **Financial** **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
**Function Library** **Defined Names** **Formula Auditing**

**SUM** **x** **✓** **fx**  $=IF(Index\ E:E=\$D4,\$A4,IF(E\$2=\$B4,\$C4,E3))$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3					13	5	3	10	14	4	8	11	7	13	9	6	12	
4	13	1	1	10	=IF(Ir	5	3	10	14	4	8	11	7	13	9	6	12	
5	5	2	3	3	1	3	5	10	14	4	8	11	7	13	9	6	12	
6	5	3	4	6	1	3	4	10	14	5	8	11	7	13	9	6	12	
7	10	4	5	6	1	3	4	5	14	10	8	11	7	13	9	6	12	
8	14	5	6	12	1	3	4	5	6	10	8	11	7	13	9	14	12	
9	10	6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	12	
10	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	12	
11	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12	
14	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
15	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
16																		
17																		
18																		

Step10 Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3

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File Home Insert Page Layout Formulas Data Review View Developer Team

**fx** **Σ** AutoSum **Logical** **Lookup & Reference** **Name Manager** **Define Name** **Trace Precedents** **Show Formulas**  
**Insert Function** **Recently Used** **Text** **Math & Trig** **Use in Formula** **Trace Dependents** **Error Checking**  
**Financial** **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
**Function Library** **Defined Names** **Formula Auditing**

SUM

 $=IF(Index\ E:E=\$D4,\$A4,IF(E\$2=\$B4,\$C4,E3))$ 

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3					13	5	3	10	14	4	8	11	7	13	9	6	12	
4	13	1	1	10	=IF(Ir	5	3	10	14	4	8	11	7	13	9	6	12	
5	5	2	3	3	1	3	10	14	4	8	11	7	13	9	6	12		
6	5	3	4	6	1	3	10	14	4	8	11	7	13	9	6	12		
7	10	4	5	6	1	3	10	14	4	8	11	7	13	9	6	12		
8	14	5	6	12	1	3	10	14	4	8	11	7	13	9	6	12		
9	10	6	7	9	1	3	4	5	6	7	8	11	10	13	9	6	12	
10	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	6	12	
11	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12	
14	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
15	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
16																		
17																		
18																		

And adding ' E:E' is optional. If you remove it, Excel assumes you want the intersection of the range and the cell you are in.

File Home Insert Page Layout Formulas Data Review View Developer Team

**fx** **Σ** AutoSum **Logical** **Lookup & Reference** **Name Manager** **Define Name** **Trace Precedents** **Show Formulas**  
**Insert Function** **Recently Used** **Text** **Math & Trig** **Use in Formula** **Trace Dependents** **Error Checking**  
**Financial** **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
**Function Library** **Defined Names** **Formula Auditing**

Watch Window Calculation Options Calculation

SUM

 $=IF(Index\ E:E=\$D4,\$A4,IF(E\$2=\$B4,\$C4,E3))$ 

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3					13	5	3	10	14	4	8	11	7	13	9	6	12	
4	13	1	1	10	=IF(Ir	5	3	10	14	4	8	11	7	13	9	6	12	
5	5	2	3	3	1	3	10	14	4	8	11	7	13	9	6	12		
6	5	3	4	6	1	3	10	14	4	8	11	7	13	9	6	12		
7	10	4	5	6	1	3	10	14	4	8	11	7	13	9	6	12		
8	14	5	6	12	1	3	10	14	4	8	11	7	13	9	6	12		
9	10	6	7	9	1	3	10	14	4	8	11	7	13	9	6	12		
10	8	7	8	7	1	3	10	14	4	8	11	7	13	9	6	12		
11	11	8	9	11	1	3	10	14	4	8	11	7	13	9	6	12		
12	10	9	10	9	1	3	10	14	4	8	11	7	13	9	6	12		
13	13	10	11	11	1	3	10	14	4	8	11	7	13	9	6	12		
14	13	11	12	13	1	3	10	14	4	8	11	7	13	9	6	12		
15	14	12	13	13	1	3	10	14	4	8	11	7	13	9	6	12		
16																		
17																		
18																		

And adding 'E:E' is optional. If you remove it, Excel assumes you want the intersection of the range and the cell you are in.

So we can simplify

SelectionSort.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Developer Team

fx **Σ AutoSum** Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents Error Checking Watch Window  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula Calculation Options Calculation

SUM =IF(Index=\$D4,\$A4,IF(E\$2=\$B4,\$C4,E3))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3					13	5	3	10	14	4	8	11	7	13	9	6	12	
4	13	1	1	10	=IF(13	5	3	10	14	4	8	11	7	13	9	6	12	
5	5	2	3	3	1	3	10	14	4	8	11	7	13	9	6	12		
6	5	3	4	6	1	3	10	14	4	8	11	7	13	9	6	12		
7	10	4	5	6	1	3	10	14	4	8	11	7	13	9	6	12		
8	14	5	6	12	1	3	10	14	4	8	11	7	13	9	6	12		
9	10	6	7	9	1	3	4	5	6	7	8	11	10	13	9	6	12	
10	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	6	12	
11	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12	
14	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
15	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
16																		
17																		
18																		

Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4

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And adding ' E:E' is optional. If you remove it, Excel assumes you want the intersection of the range and the cell you are in.

So we can simplify

SelectionSort.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Developer Team

fx **Σ AutoSum** Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library

Trace Precedents Show Formulas  
Trace Dependents Error Checking  
Remove Arrows Evaluate Formula  
Watch Window  
Calculation Options Calculation

SUM Min

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2	↓	↓	↓	↓	13	5	3	10	14	4	8	11	7	1	9	6	12	
3	13	1	1	10	1	5	3	10	14	4	8	11	7	13	9	6	12	
4	5	2	3	3	1	3	5	10	14	4	8	11	7	13	9	6	12	
5	5	3	4	6	1	3	5	10	14	4	8	11	7	13	9	6	12	
6	10	4	5	6	1	3	5	10	14	4	8	11	7	13	9	6	12	
7	14	5	6	12	1	3	5	6	10	8	11	7	13	9	6	12		
8	10	6	7	9	1	3	4	5	6	7	8	11	7	13	9	14	12	
9	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	12	
10	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
11	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	13	10	11	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
14	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
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17																		
18																		

Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4

Edit

140%

We can repeat this trick

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fx **Σ AutoSum** Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents Error Checking Watch Window  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula Calculation Options Calculation

Function Library

SUM =IF(Index=\$D4,\$A4,IF(E\$2=\$B4,\$C4,E3))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	7	1	9	6	12	
3					13	5	3	10	14	4	8	11	7	13	9	6	12	
4	13	1	1	10	=IF(1r	5	3	10	14	4	8	11	7	13	9	6	12	
5	5	2	3	3	1	3	5	10	14	4	8	11	7	13	9	6	12	
6	5	3	4	6	1	3	5	10	14	5	8	11	7	13	9	6	12	
7	10	4	5	6	1	3	5	10	14	10	8	11	7	13	9	6	12	
8	14	5	6	12	1	3	5	6	10	8	11	7	13	9	14	12		
9	10	6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	12	
10	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	12	
11	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12	
14	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
15	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
16																		
17																		
18																		

Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4

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SUM =IF(Index=IndexMin,Swap,IF(Index=IndexSwap,Min,E3))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	7	9	10	11	12	13	
3					13	5	3	10	14	4	8	7	9	10	11	12	13	
4	13	1	1	10	=IF(	5	3	10	14	4	8	11	13	15	17	19	21	
5	5	2	3	3	1	3	5	10	14	4	8	11	13	15	17	19	21	
6	5	3	4	6	1	3	4	10	14	5	8	11	13	15	17	19	21	
7	10	4	5	6	1	3	4	5	14	10	8	11	13	15	17	19	21	
8	14	5	6	12	1	3	4	5	6	10	8	11	13	15	17	19	21	
9	10	6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	12	
10	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	12	
11	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12	
14	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
15	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
16																		
17																		
18																		

Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4

140%

Isn't that nice?

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SUM =IF(Index=IndexMin,Swap,IF(Index=IndexSwap,  
Min,E3))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	7	9	6	12			
4	13	1	1	10	=IF(	5	3	10	14	4	8	11	7	13	9	6	12	
5	5	2	3	3	1	3	5	10	14	4	8	11	7	13	9	6	12	
6	5	3	4	6	1	3	4	10	14	5	8	11	7	13	9	6	12	
7	10	4	5	6	1	3	4	5	14	10	8	11	7	13	9	6	12	
8	14	5	6	12	1	3	4	5	6	10	8	11	7	13	9	14	12	
9	10	6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	12	
10	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	12	
11	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12	
14	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
15	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
16																		
17																		
18																		

Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4

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SUM =IF(Index=IndexMin,Swap,IF(Index=IndexSwap,  
Min,E3))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	7	9	6	12			
3					1	2	3	4	5	6	7	8	9	10	11	12	13	
4	13		1	1	10	=I	13	14	15	16	17	18	19	20	21	22	23	
5	5		2	3	3	1	2	3	4	5	6	7	8	9	10	11	12	
6	5		3	4	6	1	2	3	4	5	6	7	8	9	10	11	12	
7	10		4	5	6	1	2	3	4	5	6	7	8	9	10	11	12	
8	14		5	6	12	1	2	3	4	5	6	7	8	9	10	11	12	
9	10		6	7	9	1	2	3	4	5	6	7	8	9	10	11	12	
10	8		7	8	7	1	2	3	4	5	6	7	8	9	10	11	12	
11	11		8	9	11	1	2	3	4	5	6	7	8	9	10	11	12	
12	10		9	10	9	1	2	3	4	5	6	7	8	9	10	11	12	
13	13		10	11	11	1	2	3	4	5	6	7	8	9	10	11	12	
14	13		11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	
15	14		12	13	13	1	2	3	4	5	6	7	8	9	10	11	12	
16																		
17																		
18																		

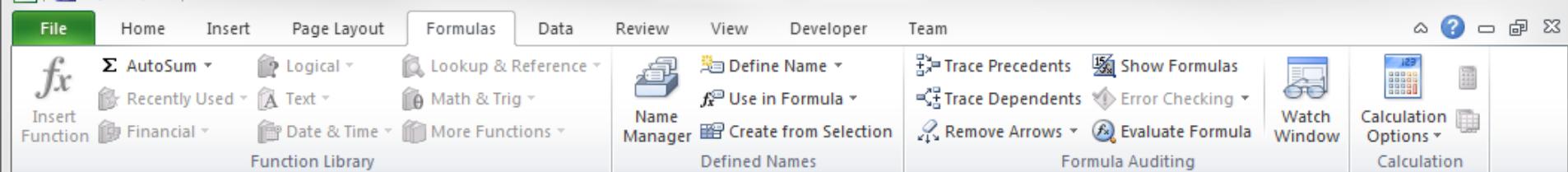
Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4

140%

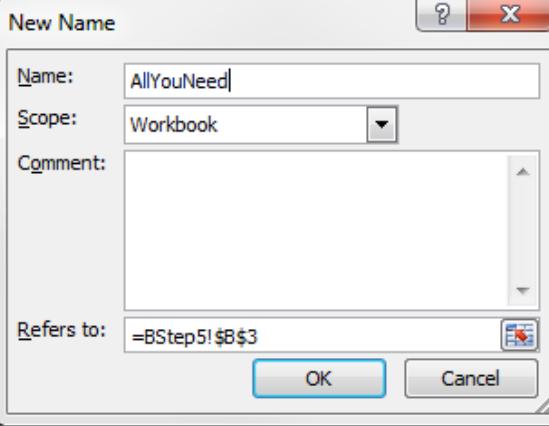
To fix that, we need  
to dive into named  
ranges



A2:B7



So far, we have used named ranges, to name, well, ranges.



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fx AutoSum Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
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Financial Date & Time More Functions Create from Selection Remove Arrows Evaluate Formula  
Function Library Name Manager Defined Names Watch Window Calculation Options  
Calculation

B3 fx

A B C D E F G H I J K

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18

New Name

Name: AllYouNeed

Scope: Workbook

Comment:

Refers to: =

OK Cancel

So far, we have used named ranges, to name, well, ranges.

But we can also name:

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Financial Date & Time More Functions Create from Selection Remove Arrows Evaluate Formula  
Function Library Name Manager Defined Names Watch Window Calculation Options  
Calculation

B3

A B C D E F G H I J K

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18

New Name

Name: AllYouNeed  
Scope: Workbook  
Comment:  
Refers to: ="Love"  
OK Cancel

All You Need is Love...

So far, we have used named ranges, to name, well, ranges.

But we can also name: strings

Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

SUM    =AllYouNeed

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		AllYouNeed									
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

All You Need is Love...

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AutoSum Logical Lookup & Reference Define Name Trace Precedents Show Formulas Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking Financial Date & Time More Functions Create from Selection Remove Arrows Evaluate Formula Watch Window Calculation Options Calculation

Insert Function Function Library

Calculation Options Calculation

Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

Edit

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Insert Function Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking Watch Window  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Formula Auditing

B3 =AllYouNeed

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		Love									
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

Love is All You Need!

Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

Ready

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Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking Watch Window  
Insert Function Financial Date & Time More Functions Create from Selection Remove Arrows Evaluate Formula  
Function Library

Name Manager Defined Names

Trace Dependents Error Checking Watch Window Calculation Options

Calculation

B3 =AllYouNeed

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		Love									
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

But we can name funkier stuff, let's stick with the love theme!

Love is All You Need!

Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

Ready

# *Paolo Nutini*

these streets



**“However much I love you,  
You will always love me  
more”**



# *Paolo Nutini*

these streets



This too can be  
expressed with a  
named range

**“However much I love you,  
You will always love me  
more”**

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Insert Function Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Watch Window Calculation Options Calculation

C3 =MyLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3			Lov <b>e</b>								
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

We can put a constant in (nothing new so far)

Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

File Home Insert Page Layout Formulas Data Review View Developer Team

AutoSum Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Insert Function Financial Date & Time More Functions Create from Selection Remove Arrows Evaluate Formula  
Function Library Name Manager Defined Names Watch Window Calculation Options  
Formula Auditing Calculation

C3 =MyLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3			Love								
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

New Name

Name: YourLove

Scope: Workbook

Comment:

Refers to: =

OK Cancel

Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

Enter

140%

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Insert Function Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Create from Selection Remove Arrows Evaluate Formula  
Function Library Name Manager Defined Names Watch Window Calculation Options  
Calculation

C3 15

A B C D E F G H I J K

1  
2  
3 Love  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18

New Name

Name: YourLove  
Scope: Workbook  
Comment:  
Refers to: =1.3\*MyLove

OK Cancel

But we can also put a formula in

Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

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**fx** **Σ AutoSum** Logical **Lookup & Reference** Define Name Trace Precedents Show Formulas  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents Error Checking Watch Window  
Financial Date & Time More Functions Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Formula Auditing

SUM

x ✓ fx

=YourLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3	Love		15								
4	YourLove		=YourLove								
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											



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**fx** **Σ AutoSum** **Logical** **Lookup & Reference** **Name Manager** **Define Name** **Trace Precedents** **Show Formulas**  
Insert Function **Recently Used** **A Text** **Math & Trig** **Use in Formula** **Trace Dependents** **Error Checking**  
**Financial** **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
Function Library **Defined Names** **Formula Auditing**

Watch Window Calculation Options Calculation

C4



=YourLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3	Love		15								
4	YourLove		19.5								
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

Looks like a range,  
but is a formula



**armin van buuren**  
feat. racoon love you more

**"Everyday I love you more"**

Named ranges  
got you covered  
again!



**ARMIN  
VAN BUUREN**

**.org**

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**Insert Function** **AutoSum** **Logical** **Lookup & Reference** **Name Manager** **Define Name** **Trace Precedents** **Show Formulas**  
**Recently Used** **Text** **Math & Trig** **Use in Formula** **Trace Dependents** **Error Checking**  
**Financial** **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
Function Library **Defined Names** **Formula Auditing**

Watch Window Calculation Options Calculation

C5

fx

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3			Love								
4		Day 1		15							
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

What we want  
now, is to refer to  
the cell in C4,  
and then  
increase its value

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**fx** AutoSum Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Formula Auditing

SUM

=ROW

	A	B	C	D	E	F	G	H	I	J	K
1				ROW	Returns the row number of a reference						
2				ROWS							
3		Love			=ROW						
4		Day 1	15								
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

What we want now, is to refer to the cell in C4, and then increase its value

**ROW(cell)** results in the row of a cell, for example  $\text{ROW(A8)} = 8$ . Without arguments  $\text{ROW}$  returns the current row.

We can use the  $\text{ROW}$  for that

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**fx** **Σ AutoSum** **Logical** **Lookup & Reference** **Name Manager** **Define Name** **Trace Precedents** **Show Formulas**  
Insert Function **Recently Used** **A Text** **Math & Trig** **Use in Formula** **Trace Dependents** **Error Checking**  
**Financial** **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
Function Library **Defined Names** **Formula Auditing**

Watch Window Calculation Options Calculation

F3



=ROW()

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		Love				3					
4		Day 1		15							
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

What we want now, is to refer to the cell in C4, and then increase its value

We can use the ROW for that

**ROW(cell)** results in the row of a cell, for example  $\text{ROW(A8)} = 8$   
Without arguments **ROW** returns the current row.  
3 in this case

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Insert Function Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Watch Window Calculation Options Calculation

C5



=YesterdaysLove

A B C D E F G H I J K

1

2

3 Love

4 Day 1

5

6

7

8

9

10

11

12

13

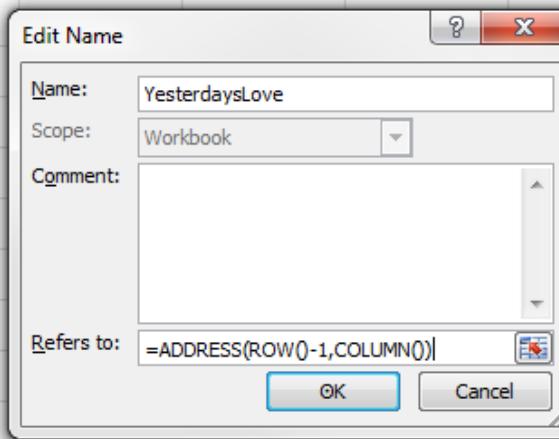
14

15

16

17

18



We can use that  
to create the  
address of the  
cell above, as  
such

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Σ AutoSum ▾ Logical ▾ Lookup & Reference ▾ Define Name ▾ Trace Precedents ▾ Show Formulas  
Recently Used ▾ Text ▾ Math & Trig ▾ Use in Formula ▾ Trace Dependents ▾ Error Checking ▾  
Insert Function Financial ▾ Date & Time ▾ More Functions ▾ Name Manager Create from Selection Remove Arrows ▾ Evaluate Formula  
Function Library Defined Names Formula Auditing

C5 =YesterdaysLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3			Love								
4		Day 1		15							
5			\$C\$4								
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

The cell above

Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

Enter

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Σ AutoSum ▾ Logical ▾ Lookup & Reference ▾ Define Name ▾ Trace Precedents ▾ Show Formulas  
fx Recently Used ▾ Text ▾ Math & Trig ▾ Use in Formula ▾ Trace Dependents ▾ Error Checking ▾  
Insert Function Financial ▾ Date & Time ▾ More Functions ▾ Name Manager Create from Selection Remove Arrows ▾ Evaluate Formula  
Function Library Defined Names Formula Auditing

C5 =YesterdaysLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3			Love								
4		Day 1		15							
5			\$C\$4								
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

But we need the value of the cell rather than the address. Excel's got you covered!

Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

Enter

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**fx** AutoSum Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Formula Auditing

SUM

 $=INDIRECT("B3")$ 

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		Love			=INDIRECT("B3")						
4		Day 1		15							
5			\$C\$4								
6											
7	<b>But we need the value of the cell rather than the address. Excel's got you covered!</b>										
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

We can use  
INDIRECT for this

File Home Insert Page Layout Formulas Data Review View Developer Team

**fx** AutoSum Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Formula Auditing

Watch Window Calculation Options Calculation

SUM

 $=INDIRECT("B3")$ 

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		Love			=INDIRECT("B3")						
4		Day 1		15							
5			\$C\$4								
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

But we need the value of the cell rather than the address. Excel's got you covered!

We can use INDIRECT for this

INDIRECT turns a string into a reference, and is in that sense similar to the 'eval' of JavaScript

File Home Insert Page Layout Formulas Data Review View Developer Team

**fx** **Σ AutoSum** **Logical** **Lookup & Reference** **Name Manager** **Define Name** **Trace Precedents** **Show Formulas**  
Insert Function **Recently Used** **A Text** **Math & Trig** **Use in Formula** **Trace Dependents** **Error Checking**  
Financial **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
Function Library **Defined Names** **Formula Auditing**

E3

 $=INDIRECT("B3")$ 

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		Love			Love						
4		Day 1		15							
5			\$C\$4								
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

So this formula



File Home Insert Page Layout Formulas Data Review View Developer Team

**fx** **Σ AutoSum** Logical **Lookup & Reference** Define Name Trace Precedents Show Formulas  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents Error Checking Watch Window  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Formula Auditing Calculation Options Calculation

E4

fx

=B3

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		Love			Love						
4		Day 1		15	Love						
5			\$C\$4		Love						
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

So this formula

Is equal to this one

File Home Insert Page Layout Formulas Data Review View Developer Team

fx **Σ AutoSum** Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents Error Checking Watch Window  
Financial Date & Time More Functions Create from Selection Remove Arrows Evaluate Formula Calculation Options Calculation

C4 =YesterdaysLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		Love									
4		Day 1									
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

Edit Name

Name: YesterdaysLove

Scope: Workbook

Comment:

Refers to: =INDIRECT(ADDRESS(ROW()-1,COLUMN()))

OK Cancel

We can use INDIRECT to get the reference to the above cell

File Home Insert Page Layout Formulas Data Review View Developer Team

**fx** **Σ AutoSum** **Logical** **Lookup & Reference** **Name Manager** **Define Name** **Trace Precedents** **Show Formulas**  
**Insert Function** **Recently Used** **A Text** **Math & Trig** **Use in Formula** **Trace Dependents** **Error Checking**  
**Financial** **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
Function Library **Defined Names** **Formula Auditing**

Watch Window Calculation Options Calculation

C5



=YesterdaysLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3			Love								
4		Day 1	15								
5			15								
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

The name is now  
equal to the  
value in the cell  
above



File Home Insert Page Layout Formulas Data Review View Developer Team

AutoSum Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Insert Function Financial Date & Time More Functions Create from Selection Remove Arrows Evaluate Formula  
Function Library Name Manager Defined Names Watch Window Calculation Options  
Calculation

C5 =YesterdaysLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		Love									
4		Day 1									
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

New Name

Name: TodaysLove

Scope: Workbook

Comment:

Refers to: =

OK Cancel

Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

Enter

140%

File Home Insert Page Layout Formulas Data Review View Developer Team

**fx** **Σ AutoSum** Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Watch Window Calculation Options Calculation

C5



=YesterdaysLove

A B C D E F G H I J K

1

2

3 Love

4 Day 1

5

6

7

8

9

10

11

12

13

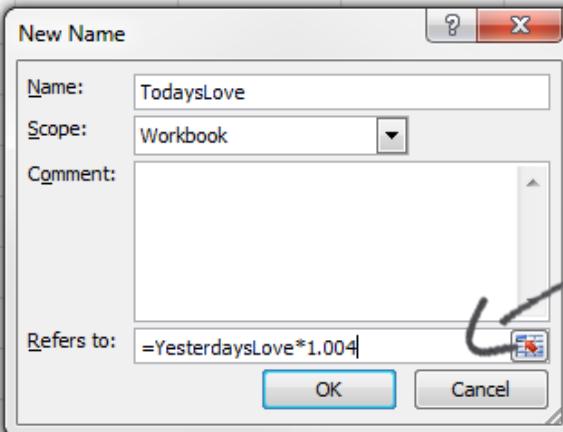
14

15

16

17

18



Just add the  
'van Buuren  
factor'

File Home Insert Page Layout Formulas Data Review View Developer Team

**fx** **Σ AutoSum** Logical **Lookup & Reference** Define Name Trace Precedents Show Formulas  
Insert Function **Recently Used** Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names

Watch Window Calculation Options Calculation

SUM

x ✓ fx

=TodaysLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3			Love								
4		Day 1		15							
5				=TodaysL							
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

File Home Insert Page Layout Formulas Data Review View Developer Team

**fx** AutoSum Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names

Watch Window Calculation Options Calculation

C5



=TodaysLove

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3			Love								
4		Day 1	15								
5		Day 2	15.06								
6		Day 3	15.1202								
7		Day 4	15.1807								
8		Day 5	15.2414								
9		Day 6	15.3024								
10		Day 7	15.3636								
11		Day 8	15.4251								
12		Day 9	15.4868								
13		Day 10	15.5487								
14		Day 11	15.6109								
15		Day 12	15.6734								
16											
17											
18											

Now we have a formula in a named range that depends on the cell you call it from



SelectionSort.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Developer Team

fx AutoSum Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Insert Function Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Watch Window Calculation Options Calculation

SUM =IF(Index=IndexMin,Swap,IF(Index=IndexSwap,  
Min,E3))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	12	13	14	15	16	
4	13	1	1	10	=IF(	5	3	10	14	4	8	11	12	13	14	15	16	
5	5	2	3	3	1	3	5	10	14	4	8	11	12	13	14	15	16	
6	5	3	4	6	1	3	4	10	14	5	8	11	12	13	14	15	16	
7	10	4	5	6	1	3	4	5	14	10	8	11	12	13	14	15	16	
8	14	5	6	12	1	3	4	5	6	10	8	11	7	13	9	14	12	
9	10	6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	12	
10	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	12	
11	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12	
14	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
15	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
16																		
17																		
18																		

Step11 Step12 Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4

140%

SelectionSort.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Developer Team

fx AutoSum Logical Lookup & Reference Define Name Trace Precedents Show Formulas  
Insert Function Recently Used Text Math & Trig Use in Formula Trace Dependents Error Checking  
Financial Date & Time More Functions Name Manager Create from Selection Remove Arrows Evaluate Formula  
Function Library Defined Names Watch Window Calculation Options Calculation

A3 =PreviousRow

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin	1	2	3	4	5	6	7	8	9	10	11	12	13	
2					13	5	3	10	14	4	8	11	12	13	14	1	2	3
3					1	2	3	4	5	6	7	8	9	10	11	12	13	
4	13	1	1		5	3	10	14	4	8	11	12	13	14	1	2	3	
5	5		2	3	13	5	3	10	14	4	8	11	12	13	14	1	2	3
6	5		3	4	5	3	10	14	4	8	11	12	13	14	1	2	3	
7	10		4	5	5	3	10	14	4	8	11	12	13	14	1	2	3	
8	14		5	6	10	8	11	7	13	10	8	11	7	13	9	14	12	
9	10		6	7	10	8	11	7	13	10	8	11	7	13	9	14	12	
10	8		7	8	10	8	11	7	13	10	8	11	7	13	9	14	12	
11	11		8	9	11	12:11	3	4	5	6	7	8	9	10	11	12	13	
12	10		9	10	11	12:11	3	4	5	6	7	8	9	10	11	12	13	
13	13		10	11	11	12:11	3	4	5	6	7	8	9	10	11	12	13	
14	13		11	12	11	13:13	3	4	5	6	7	8	9	10	11	12	13	
15	14		12	13	13	14:14	3	4	5	6	7	8	9	10	11	12	13	
16																		
17																		
18																		

Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6

Point 140% 140%

We can use this named ranged trick to get rid of that UGLY E3!  
By making a named range which points to the row above (we use the row:row syntax)

File Home Insert Page Layout Formulas Data Review View Developer Team

**Insert Function**

**AutoSum** **Logical** **Lookup & Reference** **Define Name** **Trace Precedents** **Show Formulas**  
**Recently Used** **Text** **Math & Trig** **Name Manager** **Use in Formula** **Trace Dependents** **Error Checking**  
**Financial** **Date & Time** **More Functions** **Create from Selection** **Remove Arrows** **Evaluate Formula**  
**Function Library** **Defined Names** **Formula Auditing**

**Watch Window** **Calculation Options** **Calculation**

E4       $=\text{IF}(\text{Index}=\text{IndexMin}, \text{Swap}, \text{IF}(\text{Index}=\text{IndexSwap}, \text{Min}, \text{PreviousRow}))$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13	1	1	10	1	5	3	10	14	4	8	11	7	13	9	6	12	
5	5	2	3	3	1	3	5	10	14	4	8	11	7	13	9	6	12	
6	5	3	4	6	1	3	4	10	14	5	8	11	7	13	9	6	12	
7	10	4	5	6	1	3	4	5	14	10	8	11	7	13	9	6	12	
8	14	5	6	12	1	3	4	5	6	10	8	11	7	13	9	14	12	
9	10	6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	12	
10	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	12	
11	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12	
14	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
15	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
16																		
17																		
18																		

TADAAA!

File Home Insert Page Layout Formulas Data Review View Developer Team

**Insert Function**

**Function Library**

**Defined Names**

**Formula Auditing**

**Calculation Options**

E4      =IF(Index=IndexMin,Swap,IF(Index=IndexSwap,  
Min,PreviousRow))

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					1	2	3	4	5	6	7	8	9	10	11	12	13	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13	1	1	10	1	5	3	10	14	4	8	11	7	13	9	6	12	
5	5	2	3	3	1	3	5	10	14	4	8	11	7	13	9	6	12	
6	5	3	4	6	1	3	4	10	14	5	8	11	7	13	9	6	12	
7	10	4	5	6	1	3	4	5	14	10	8	11	7	13	9	6	12	
8	14	5	6	12	1	3	4	5	6	10	8	11	7	13	9	14	12	
9	10	6	7	9	1	3	4	5	6	7	8	11	10	13	9	14	12	
10	8	7	8	7	1	3	4	5	6	7	8	11	10	13	9	14	12	
11	11	8	9	11	1	3	4	5	6	7	8	9	10	13	11	14	12	
12	10	9	10	9	1	3	4	5	6	7	8	9	10	13	11	14	12	
13	13	10	11	11	1	3	4	5	6	7	8	9	10	11	13	14	12	
14	13	11	12	13	1	3	4	5	6	7	8	9	10	11	12	14	13	
15	14	12	13	13	1	3	4	5	6	7	8	9	10	11	12	13	14	
16																		
17																		
18																		

Doesn't that read  
like a novel?

For comparison, I  
have written selection  
sort in Python

TADAAA!

File Edit Format Options Windows Help

```
def selectionSort(List):
    for IndexSwap in range(len(List)):

        Min = min(List[IndexSwap:])
        IndexMin = List.index(Min)

        Swap = List[IndexSwap]

        for Index in range(IndexSwap, len(List)):

            if Index == IndexMin:
                List[Index] = Swap

            elif Index == IndexSwap:
                List[Index] = Min

    return List
```

Similar, but a lot less  
concise! :)

2001financialstatements.xlsx - Microsoft Excel

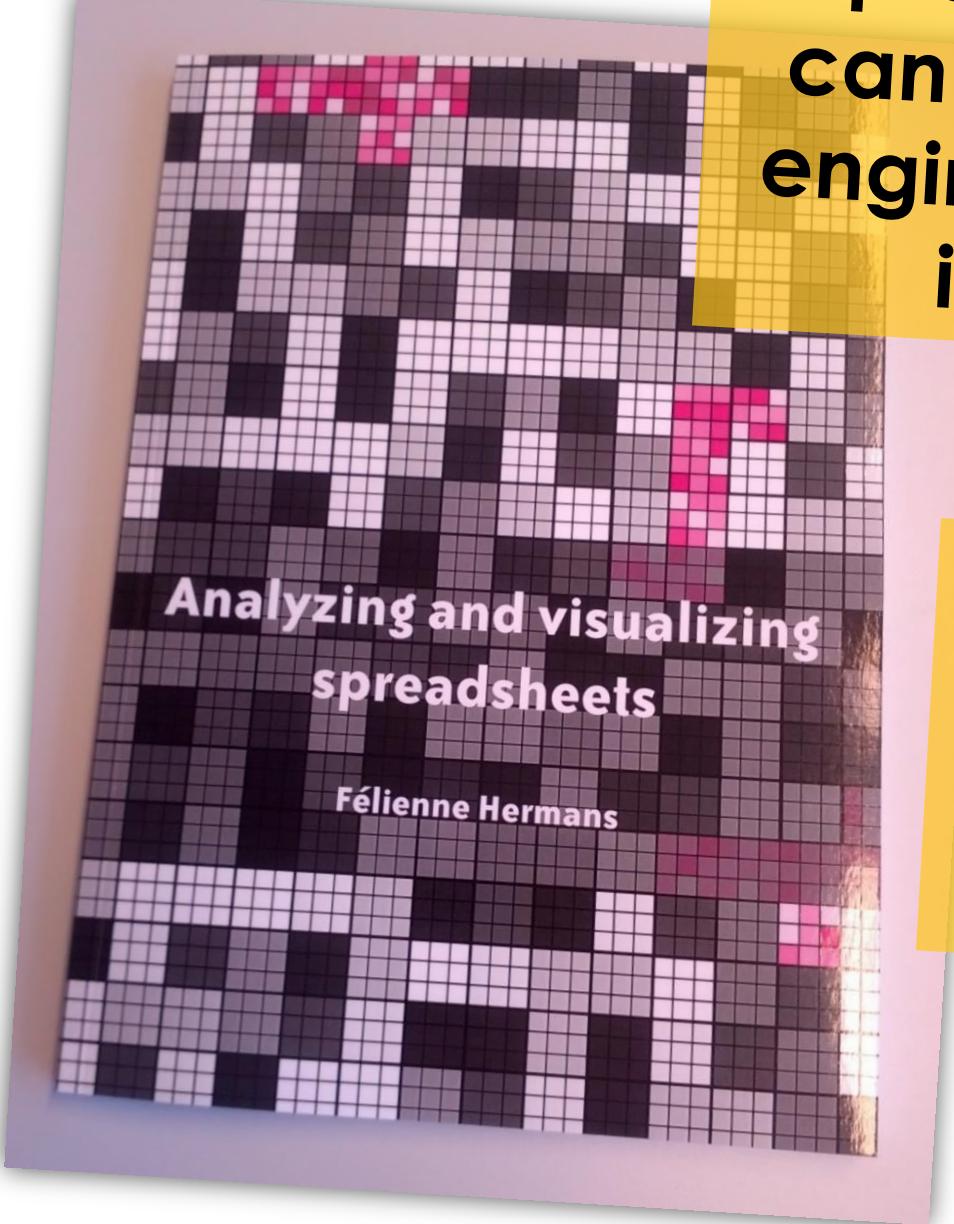
If spreadsheets are code, can we apply software engineering methods to improve them?

	A	B	C	D
1	Consolidated Statements of Shareholders' Equity			
2	[DOLLARS IN THOUSANDS]			
3				
4				
5				
6				
7		Common Shares		
8		Number	Par Value	Additional Capital
9	Balance, January 1, 1999	69,494,483	\$ 86,868	\$ 43,281
10				
11	Net income			
12	Translation adjustment			
13	Pensions			
14	Unrealized loss on investment securities			
15	Other comprehensive income			
16	Comprehensive income			
17	Stock options exercised	108,104	134	1,918
18	Unearned compensation	149,799	188	3,933
19	Performance shares	20,397	26	686
20	Procomp and Nexus acquisitions	1,710,214	2,138	37,351
21	Dividends declared and paid			
22	Treasury shares			
23				
24	Balance, December 31, 1999	71,482,997	\$ 89,354	\$ 87,169
25	Net income			
26	Translation adjustment			
27	Pensions			
28	Unrealized loss on investment securities			
29	Other comprehensive loss			
30	Comprehensive income			
31	Stock options exercised	273,238	343	5,444
32	Unearned compensation	247,635	308	5,583
33	Performance shares	15,335	19	334
34	Dividends declared and paid			
35	Treasury shares			
36				
37	Balance, December 31, 2000	536,208	\$ 90,024	\$ 98,530
38	Net income			
39	Translation adjustment			
40	Pensions			
41	Unrealized gain on investment securities			
42	Other comprehensive loss			
43	Comprehensive income			
44	Stock options exercised	176,395	221	4,860
45	Unearned compensation			
46	Dividends declared and paid			
47	Treasury shares			
48				
49	Balance, December 31, 2001	712,603	\$ 90,245	\$ 103,390
50				
51				

```
private static string MapRowToString(Record record, string tableName, int sequenceColumn)
{
    StringBuilder rowHash = new StringBuilder();
    int i = 0;
    int fieldCount = record.GetFieldCount();
    for (i = 0; i < fieldCount; i++)
    {
        if (record.IsNull(i))
        {
            rowHash.Append("null|");
        }
        else
        {
            // skip the value of ProductCode
            if (tableName == "Property"
                && i == 2
                && "|ProductCode|" == rowHash.ToString())
            {
                continue;
            }
            else if (sequenceColumn == i) // skip seq
            {
                continue;
            }

            try
            {
                rowHash.Append(record.GetString(i));
                rowHash.Append(' ');
            }
            catch // assume binary
            {
                rowHash.Append("binary| ");
            }
        }
    }
    return rowHash.ToString();
}
```

If spreadsheets are code,  
can we apply software  
engineering methods to  
improve them?



Analyzing and visualizing  
spreadsheets

Félienne Hermans

That is the  
central research  
question of my  
dissertation



The conclusion is:

YES WE  
CAN.

More info:  
[felienne.com/archives/2534](http://felienne.com/archives/2534)



**Because SE methods transfer so well, after my graduation, I built a spreadsheet refactoring tool called BumbleBee.**

TestSheet.xlsxm - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector ? X

Find applicable rewrites  
Rewrites possible Preview

Basic Options

A1 f<sub>x</sub>

	Math					
1	StudentId	Homework	Classwork	Exam	TestsTaken	Total
2	4150		56	73	2	-
3	5838	95	88	84	3	89
4	8043	80		62	2	-
5	2115	86	98	96	3	93.33333333
6	8382	64	97	81	3	80.66666667
7						
8						
9	Statistics	Math	Chemistry			
10	Highest score	93.33333333	90.66666667			
11	Lowest score	80.66666667	60.33333333			
12	Average	87.66666667	74.66666667			
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						

2011 2012 2013

Ready

Because SE methods transfer so well, after my graduation, I built a spreadsheet refactoring tool called BumbleBee.

Here you see the user interface in Excel 2010.



TestSheet.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector

Find applicable rewrites  
Rewrites possible  
Preview

Basic Options

B12      f<sub>x</sub> =SUM(F3:F7)/COUNT(F3:F7)

	A	B	C	D	E	F	G	H	I	J	K	L		
1			Math				Chemistry							
2	StudentId	Homework	Classwork	Exam	TestsTaken	Total	Homework	Classwork	Exam	TestsTaken	Total			
3	4150		56	73	2	-	57	71	53	3	60.333333333			
4	5838	95	88	84	3	89	80	71	56	3	69			
5	8043	80		62	2	-	81		68	2	-			
6	2115	86	98	96	3	93.333333333	77	99	96	3	90.666666667			
7	8382	64	97	81	3	80.666666667	76	71	89	3	78.666666667			
8														
9	Statistics	Math	Chemistry											
10	Highest score	93.333333333	90.666666667											
11	Lowest score	80.666666667	60.333333333											
12	Average	87.666666667	74.666666667											
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														

This formula is 'smelly':  
it can be improved by  
using an AVERAGE



2011 2012 2013

Ready

TestSheet.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector

Find applicable rewrites

Rewrites possible

Preview

Basic Options

B12 f =SUM(F3:F7)/COUNT(F3:F7)

You can ask BumbleBee for rewrites to apply

	A	B	C	D	E	F	G	H	I	K	L	
1			Math				Chemistry					
2	StudentId	Homework	Classwork	Exam	TestsTaken	Total	Homework	Classwork	Exam	TestsTaken	Total	
3	4150		56	73	2	-	57	71	53	3	60.333333333	
4	5838	95	88	84	3	89	80	71	56	3	69	
5	8043	80		62	2	-	81		68	2	-	
6	2115	86	98	96	3	93.333333333	77	99	96	3	90.666666667	
7	8382	64	97	81	3	80.666666667	76	71	89	3	78.666666667	
8												
9	Statistics	Math	Chemistry									
10	Highest score	93.333333333	90.666666667									
11	Lowest score	80.666666667	60.333333333									
12	Average	87.666666667	74.666666667									
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2011 2012 2013

Ready

100%

TestSheet.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector

Find applicable rewrites

Rewrites possible SUM and COUNT to AVER... Apply in Range Initialize

Preview AVERAGE(F3:F7) Apply in Sheet Apply Everywhere

Basic Options

B12 fx =SUM(F3:F7)/COUNT(F3:F7)

**BumbleBee suggests a refactoring**

	A	B	C	D	E	F						
1	Math						Chemistry					
2	StudentId	Homework	Classwork	Exam	TestsTaken	Total	Homework	Classwork	Exam	TestsTaken	Total	
3	4150		56	73	2	-	57	71	53	3	60.333333333	
4	5838	95	88	84	3	89	80	71	56	3	69	
5	8043	80		62	2	-	81		68	2	-	
6	2115	86	98	96	3	93.333333333	77	99	96	3	90.666666667	
7	8382	64	97	81	3	80.666666667	76	71	89	3	78.666666667	
8												
9	Statistics	Math	Chemistry									
10	Highest score	93.333333333	90.666666667									
11	Lowest score	80.666666667	60.333333333									
12	Average	87.666666667	74.666666667									
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2011 2012 2013

Ready

100%

TestSheet.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector ? X

Find applicable rewrites

Rewrites possible SUM and COUNT to AVER... Apply in Range Initialize

Preview AVERAGE(F3:F7) Apply in Sheet Apply Everywhere

Basic Options

B12 fx =SUM(F3:F7)/COUNT(F3:F7)

And shows you how the new formula will look like

	A	B	C	D	E	F	G	J	K	L	
1			Math				Chemistry				
2	StudentId	Homework	Classwork	Exam	TestsTaken	Total	Homework	Classwork	Exam	TestsTaken	Total
3	4150		56	73	2	-	57	71	53	3	60.333333333
4	5838	95	88	84	3	89	80	71	56	3	69
5	8043	80		62	2	-	81		68	2	-
6	2115	86	98	96	3	93.333333333	77	99	96	3	90.666666667
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2011 2012 2013

Ready

TestSheet.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector ? X

Find applicable rewrites

Rewrites possible SUM and COUNT to AVER... Preview AVERAGE(F3:F7)

Basic Options

Apply in Range Initialize  
Apply in Sheet  
Apply Everywhere

B12 f<sub>x</sub> =SUM(F3:F7)/COUNT(F3:F7)

Click apply and your formula will be refactored!

	A	B	C	D	E	F	G	H	I	J	K	L		
1			Math				Chemistry							
2	StudentId	Homework	Classwork	Exam	TestsTaken	Total	Homework	Classwork	Exam	TestsTaken	Total			
3	4150		56	73	2	-	57	71	53	3	60.333333333			
4	5838	95	88	84	3	89	80	71	56	3	69			
5	8043	80		62	2	-	81		68	2	-			
6	2115	86	98	96	3	93.333333333	77	99	96	3	90.666666667			
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2011 2012 2013

Ready

TestSheet.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector ? X

Find applicable rewrites  
Rewrites possible SUM and COUNT to AVER...  
Preview AVERAGE(F3:F7)

Basic Options

B12 f =AVERAGE(F3:F7)

Apply in Range Initialize  
Apply in Sheet  
Apply Everywhere

Click apply and your formula will be refactored!

	A	B	C	D	E	F	G	H	I	J	K	L	
1			Math					Chemistry					
2	StudentId	Homework	Classwork	Exam	TestsTaken	Total	Homework	Classwork	Exam	TestsTaken	Total		
3	4150		56	73	2	-	57	71	53	3	60.333333333		
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2011 2012 2013

Ready

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector    

Find applicable rewrites  
Rewrites possible

Basic Options

Apply in Range Initialize  
Apply in Sheet  
Apply Everywhere

	A1	B	C	D	E	F	G	H	I
1	[c]	ROUND([c],0)	5	ROUND					
2	[c]/[d]	IF([d]<>0,[c]/[d],"cannot divide by 0")	4	Add guard					
3	IF([c]<[d],[c],[d])	MIN([c],[d])	3	IF to MIN					
4	IF([c]>[d],[c],[d])	MAX([c],[d])	3	IF to MAX					
5	SUM({r})/COUNT({r})	AVERAGE({r})	2	SUM and COUNT to AVERAGE					
6									
7									
8									
9									
10									
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The transformations are  
programmable, with a  
small language

And of course, if you say  
refactoring...

# REFACTORING

## IMPROVING THE DESIGN OF EXISTING CODE

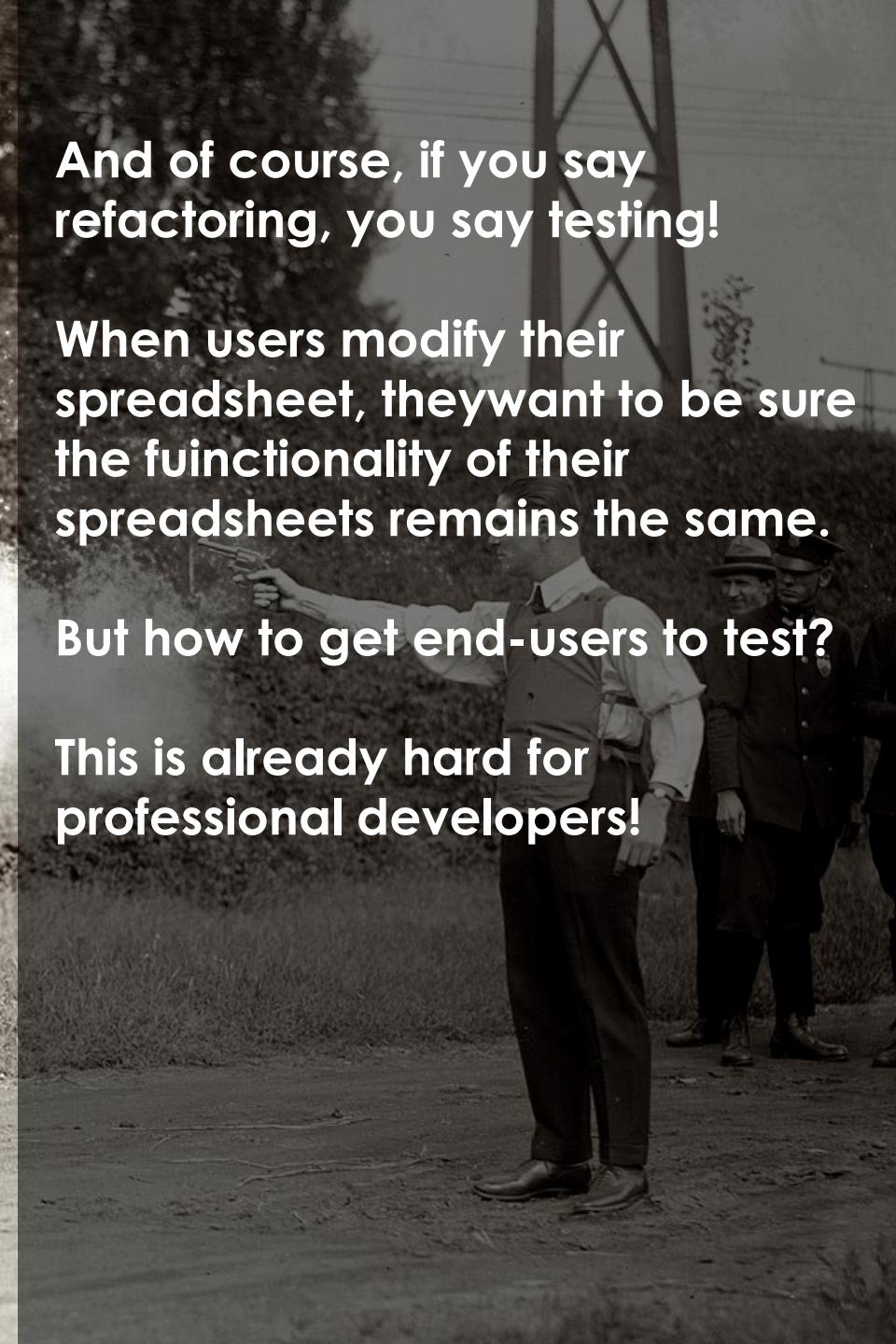
MARTIN FOWLER

Foreword by Kent Beck  
Introduction by Ward Cunningham  
Foreword by Steve Yegge

Prepared exclusively for  
John Doe <jdoe@doe.com>



**And of course, if you say refactoring, you say testing!**



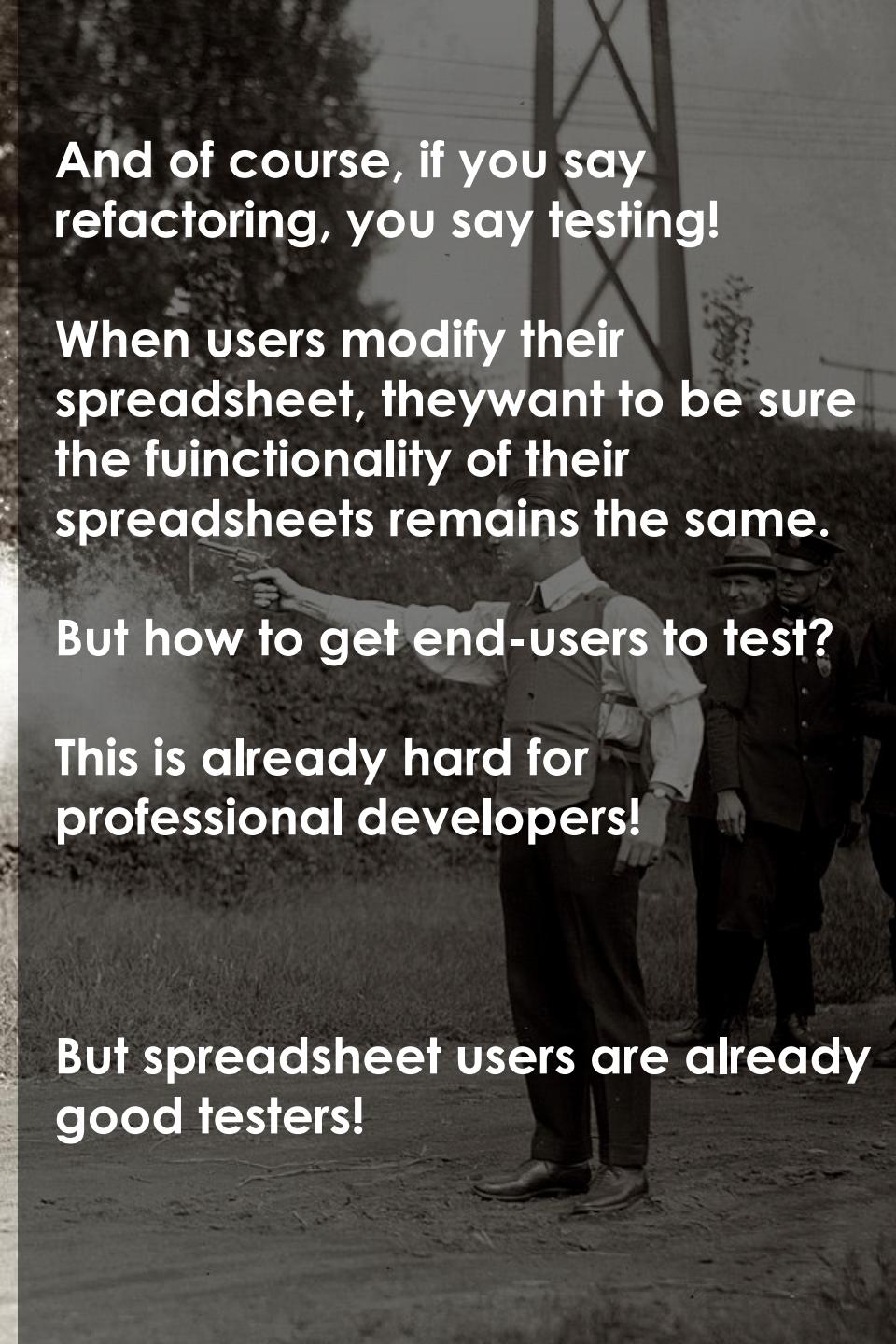
**When users modify their spreadsheet, they want to be sure the functionality of their spreadsheets remains the same.**

**But how to get end-users to test?**

**This is already hard for professional developers!**



**And of course, if you say refactoring, you say testing!**



**When users modify their spreadsheet, they want to be sure the functionality of their spreadsheets remains the same.**

**But how to get end-users to test?**

**This is already hard for professional developers!**

**But spreadsheet users are already good testers!**

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector ?

Arial 12 A A General \$ % , Conditional Formatting  
B I U Alignment Format as Table  
Font Number Cell Styles  
Clipboard Styles Cells Editing

D11 =IF(SUM(D6:D10)<>100%, "ERROR", "100%")

	A	B	C	D	E	F	G	H	I	J	K	L										
3	Name of Program: Asset Management of Federally-Owned Real Property																					
4	Section I: Program Purpose & Design (Yes, No)																					
5	Questions		Ans.	Weighting	Weighted Score																	
6	1	Is the program purpose clear?		Yes	20%	0.2																
7	2	Does the program address a specific interest, problem or need?		Yes	20%	0.2																
8	3	Is the program designed to have a significant impact in addressing the interest, problem or need?		No	20%	0.0																
9	4	Is the program designed to make a unique contribution in addressing the interest, problem or need (i.e., not needlessly redundant of any other Federal, state, local or private efforts)?		No	20%	0.0																
10	5	Is the program optimally designed to address the interest, problem or need?		Yes	20%	0.2																
11	Total Section Score		100%		60%																	
12																						
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Look at that!  
It is like a test

assetmanagement.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector ? X

Paste General \$ % , Conditional Formatting

Font Alignment Number Styles Cells Editing

D11 =IF(SUM(D6:D10)<>100%, "ERROR", "100%")

	A	B	C	D	E	F	G	H	I	J	K	L
3	Name of Program: Asset Management of Federally-Owned Real Property											
4	Section I: Program Purpose & Design (Yes, No)											
	Questions	Ans.	Weighting	Weighted Score								
6	1 Is the program purpose clear?	Yes	20%	0.2								
7	2 Does the program address a specific interest, problem or need?	Yes	20%	0.2								
8	3 Is the program designed to have a significant impact in addressing the interest, problem or need?	No	20%	0.0								
9	4 Is the program designed to make a unique contribution in addressing the interest, problem or need (i.e., not needlessly redundant of any other Federal, state, local or private efforts)?	No	20%	0.0								
10	5 Is the program optimally designed to address the interest, problem or need?	Yes	20%	0.2								
11	Total Section Score		100%	60%								
12												
13												
14												
15												
16												
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18												

**Look at that!  
It is like a test**

**We figured that rather than learning spreadsheet users a new tool, we could exploit these formulas**

PART Qs & Section Scoring

Ready Calculate 80%

assetmanagement.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins VBA Load Test BumbleBee Expector ? X

Find Tests Mark Non-Covered Formulas

Mark Tests

Mark Covered Formulas

D11 f<sub>x</sub> =IF(SUM(D6:D10)<>100%,"ERROR","100%")

A B C D E F G H I J K L

3 Name of Program: Asset Management of Federally-Owned Real Property

4 Section I: Program Purpose & Design (Yes, No)

	Questions	Ans.	Weighting	Weighted Score		
6 1	Is the program purpose clear?	Yes	20%	0.2		
7 2	Does the program address a specific interest, problem or need?	Yes	20%			
8 3	Is the program designed to have a significant impact in addressing the interest, problem or need?	No	20%			
9 4	Is the program designed to make a unique contribution in addressing the interest, problem or need (i.e., not needlessly redundant of any other Federal, state, local or private efforts)?	No	20%			
10 5	Is the program optimally designed to address the interest, problem or need?	Yes	20%			
11 Total Section Score		100%	60%			
12	13	14	15	16	17	18

PART Qs & Section Scoring

Expector

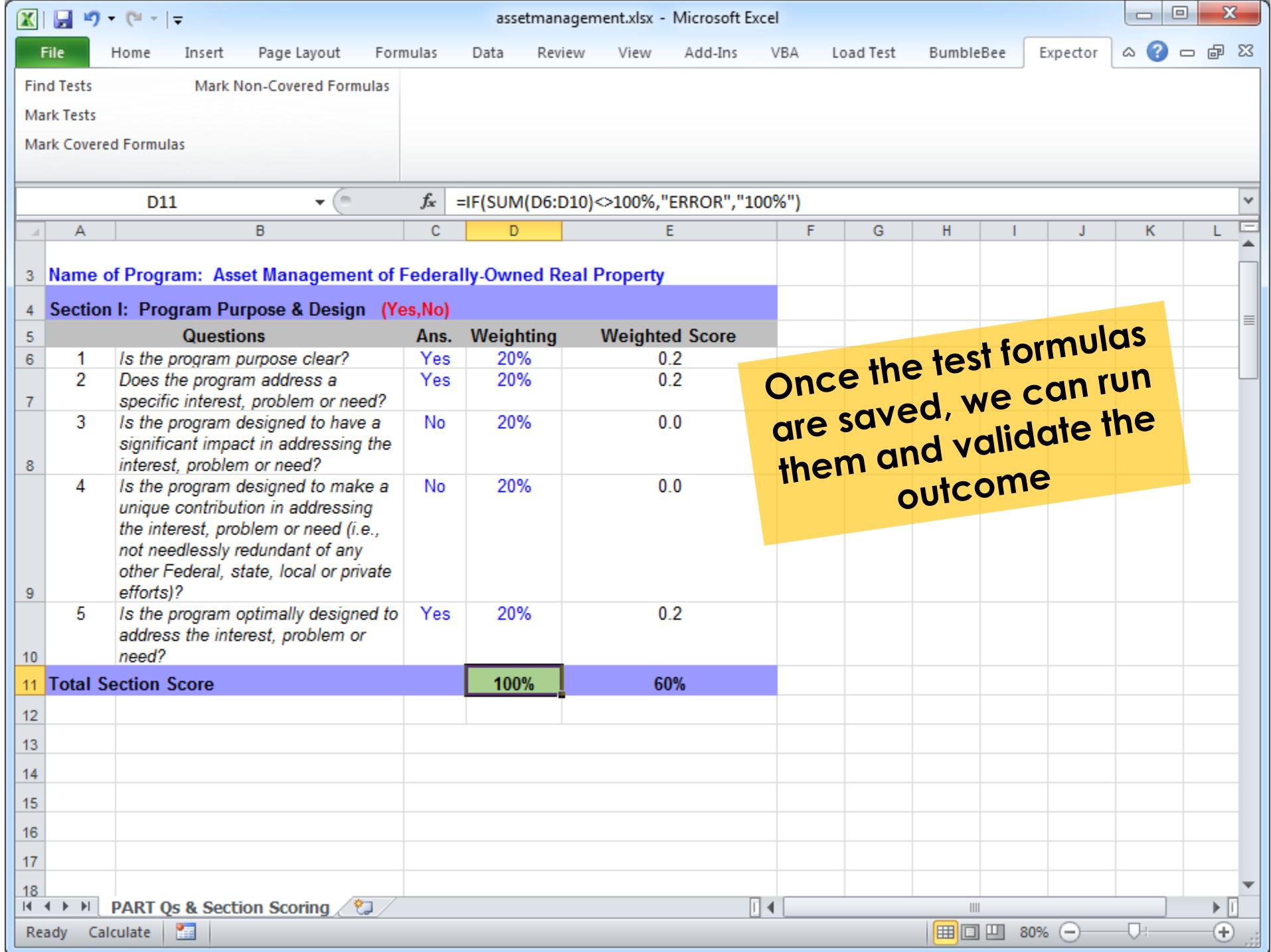
Detected test formulas: D11: =IF(SUM(D6:D10)<>100%,"ERROR","100%")

Detected outcomes: <>100% Fail

= 100% Pass

Save tests Cancel

So we built Expector: a tool that can detect these test formulas and save them in a 'test suite'



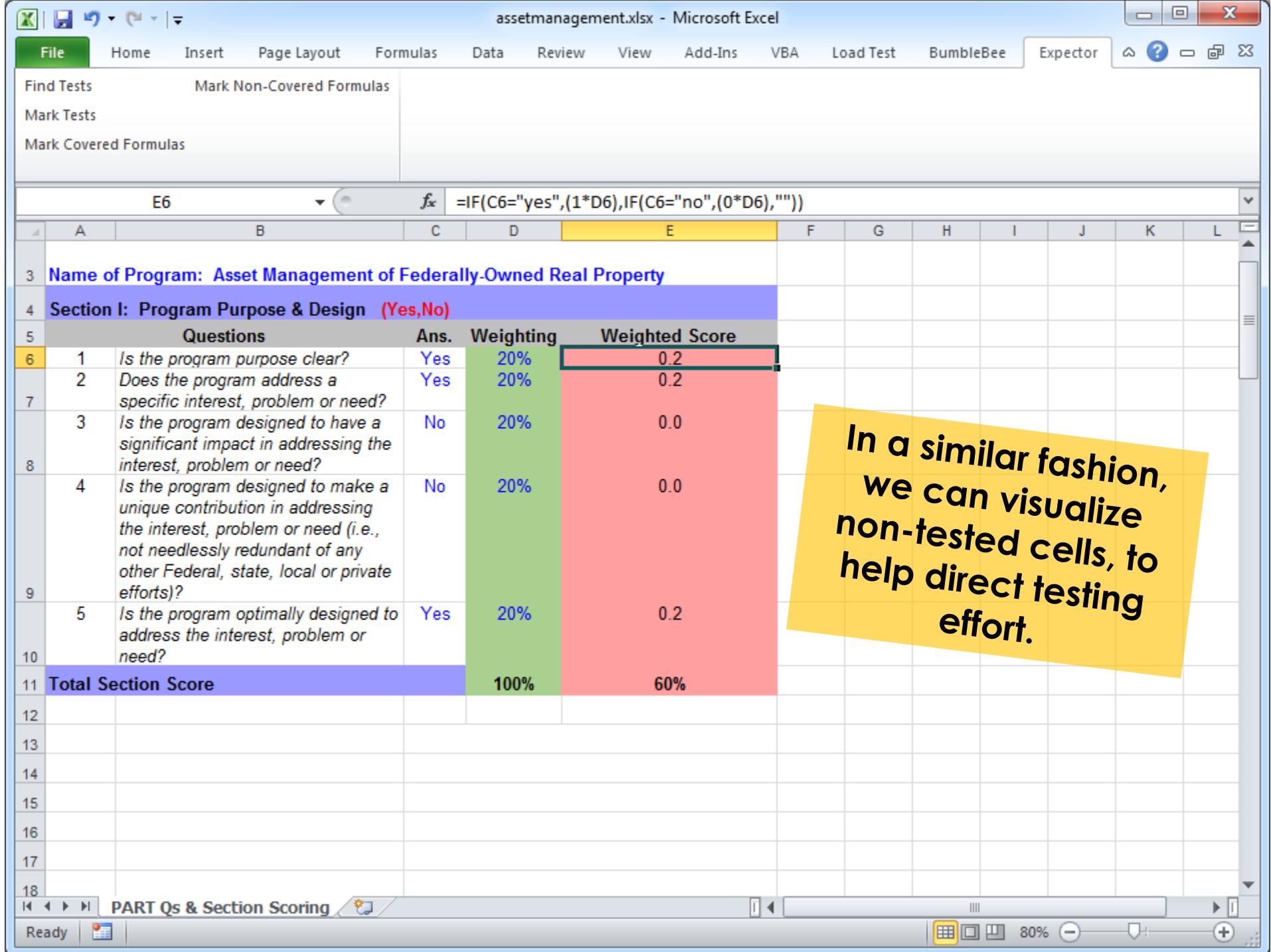
assetmanagement.xlsx - Microsoft Excel																			
File	Home	Insert	Page Layout	Formulas	Data	Review	View	Add-Ins	VBA	Load Test	BumbleBee	Expector							
Find Tests		Mark Non-Covered Formulas																	
Mark Tests																			
Mark Covered Formulas																			
D11			f <sub>x</sub>	=IF(SUM(D6:D10)<>100%,"ERROR","100%")															
A	B	C	D	E	F	G	H	I	J	K	L								
3	Name of Program: Asset Management of Federally-Owned Real Property																		
4	Section I: Program Purpose & Design (Yes, No)																		
5	Questions		Ans.	Weighting	Weighted Score														
6	1 Is the program purpose clear?		Yes	20%	0.2														
7	2 Does the program address a specific interest, problem or need?		Yes	20%	0.2														
8	3 Is the program designed to have a significant impact in addressing the interest, problem or need?		No	20%	0.0														
9	4 Is the program designed to make a unique contribution in addressing the interest, problem or need (i.e., not needlessly redundant of any other Federal, state, local or private efforts)?		No	20%	0.0														
10	5 Is the program optimally designed to address the interest, problem or need?		Yes	20%	0.2														
11	Total Section Score				100%	60%													
12																			
13																			
14																			
15																			
16																			
17																			
18																			
PART Qs & Section Scoring																			
Ready	Calculate	Save	Print	Find	Sort	Filter	Format	Format	Format	Format	Format	Format							
80%	+	-	0	100%	50%	25%	75%	33%	66%	11%	88%	44%							

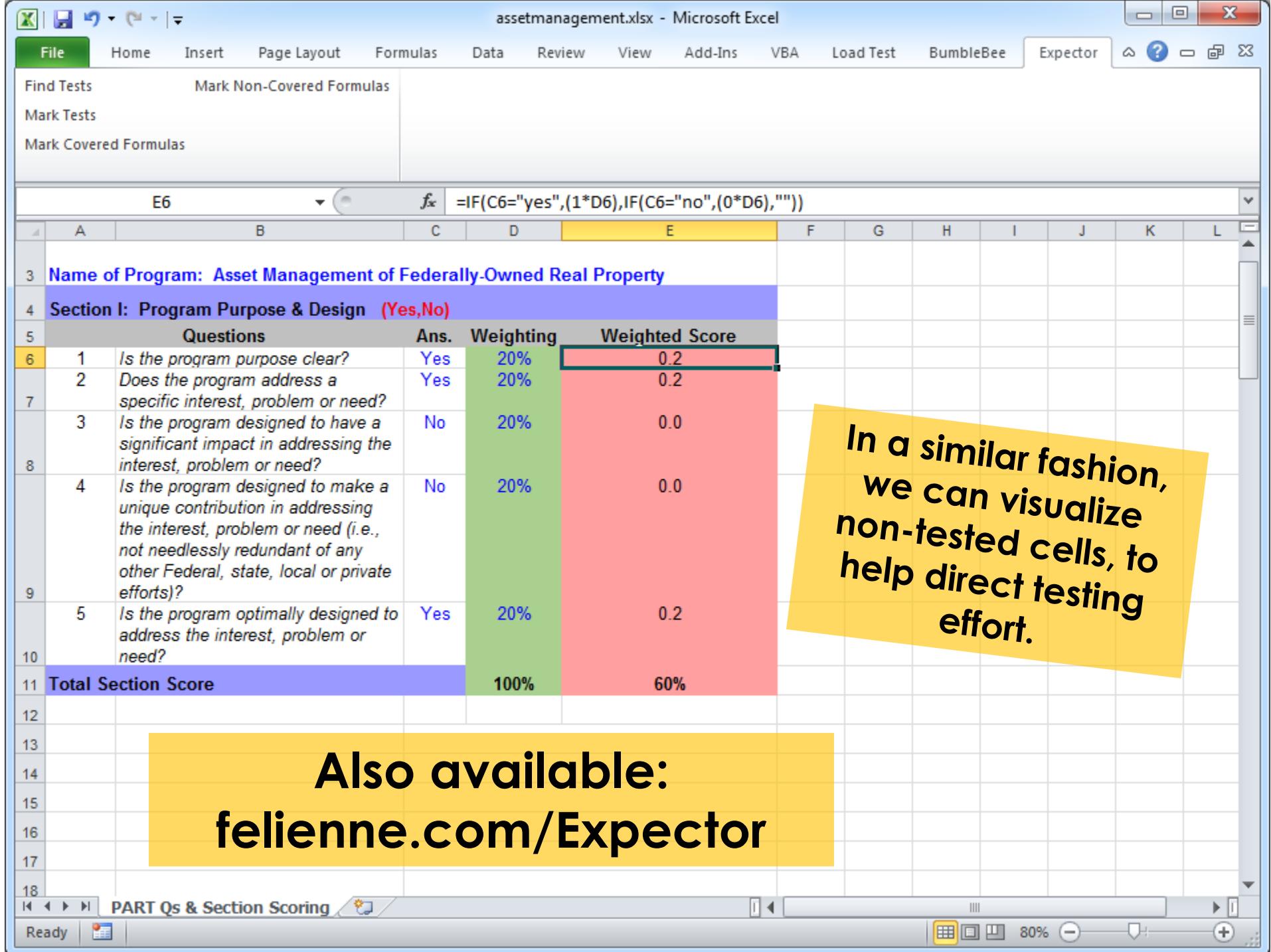
Once the test formulas are saved, we can run them and validate the outcome

We can even show 'coverage', by taking the cell dependencies into account

assetmanagement.xlsx - Microsoft Excel												
File	Home	Insert	Page Layout	Formulas	Data	Review	View	Add-Ins	VBA	Load Test	BumbleBee	Expector
Find Tests	Mark Non-Covered Formulas											
Mark Tests												
Mark Covered Formulas												
D11				f <sub>x</sub>	=IF(SUM(D6:D10)<>100%,"ERROR","100%")							
A	B	C	D	E	F	G	H	I	J	K	L	
3	<b>Name of Program: Asset Management of Federally-Owned Real Property</b>											
4	<b>Section I: Program Purpose &amp; Design (Yes,No)</b>											
5	Questions	Ans.	Weighting	Weighted Score								
6	1 <i>Is the program purpose clear?</i>	Yes	20%	0.2								
7	2 <i>Does the program address a specific interest, problem or need?</i>	Yes	20%	0.2								
8	3 <i>Is the program designed to have a significant impact in addressing the interest, problem or need?</i>	No	20%	0.0								
9	4 <i>Is the program designed to make a unique contribution in addressing the interest, problem or need (i.e., not needlessly redundant of any other Federal, state, local or private efforts)?</i>	No	20%	0.0								
10	5 <i>Is the program optimally designed to address the interest, problem or need?</i>	Yes	20%	0.2								
11	<b>Total Section Score</b>		100%	60%								
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17												
18												
PART Qs & Section Scoring												
Ready	Calculate											

We can even show  
 'coverage', by taking  
 the cell dependencies  
 into account





A photograph of several people in shiny gold robes singing on stage. One man in the foreground has his back to the camera, gesturing with his hands. Another man in the center is singing into a microphone. A woman in the background is also singing. The stage is lit with blue lights.

**That's all folks! Thanks for watching my talk on SlideShare!**

**Don't forget that:**

**Spreadsheets are code**

**More info?**

- [www.felienne.com](http://www.felienne.com)
- [www.spreadsheetlab.org](http://www.spreadsheetlab.org)

**Want to connect?**

- [@felienne](https://twitter.com/felienne)
- [mail@felienne.com](mailto:mail@felienne.com)