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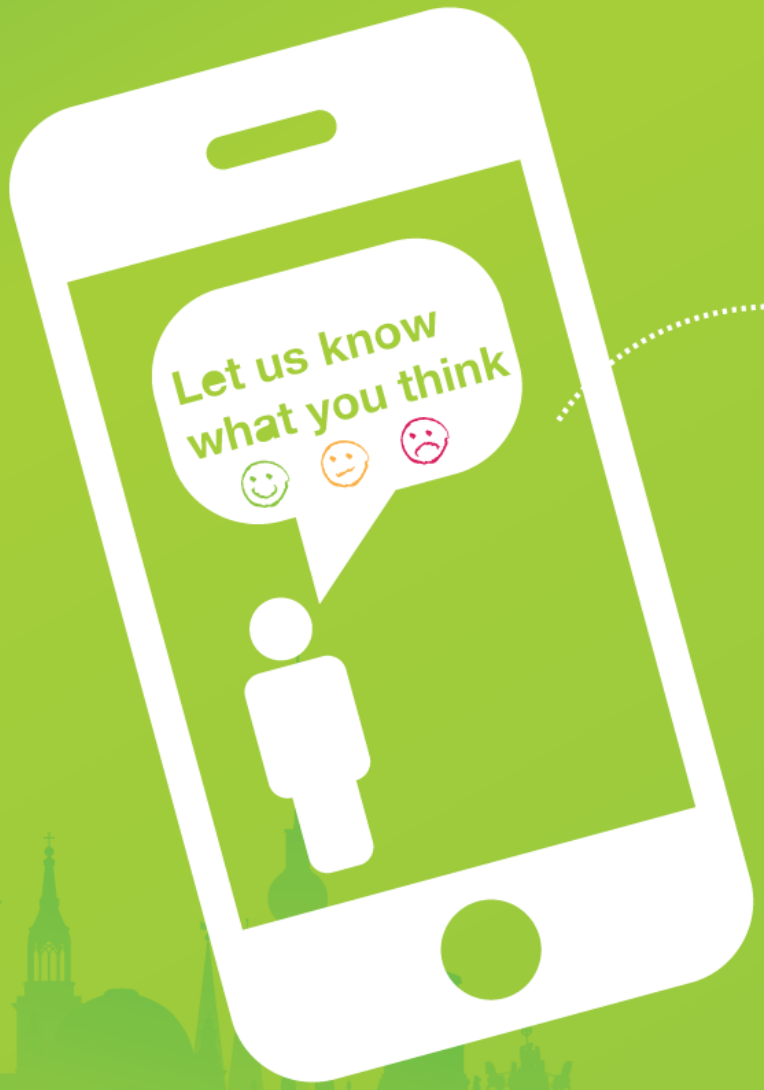

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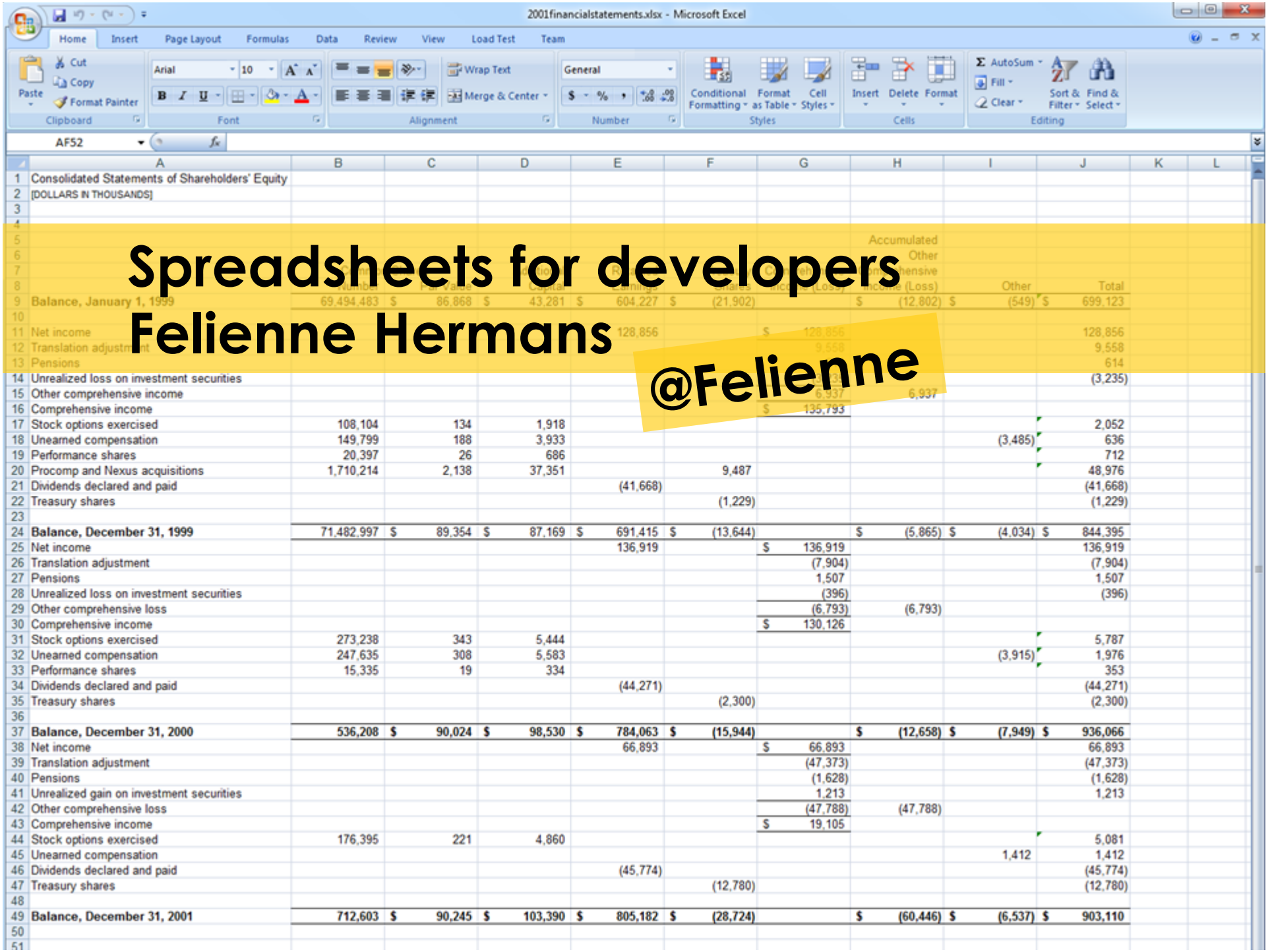
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Spreadsheets for developers
Felienne Hermans
@Felienne

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AF52

	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								Accumulated				
6								Other				
7		Common Shares		Additional	Retained	Treasury	Comprehensive	Comprehensive				
8		Number	Value	Capital	Earnings	Shares	Income (Loss)	Income (Loss)	Other	Total		
9	**Balance, January 1, 1999**	69,494,483	6,868	$ 43,281	$ 604,227	$ (21,902)		$ (12,802)	$ (549)	$ 699,123		
10												
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						(3,235)			(3,235)		
15	Other comprehensive income						6,937	6,937				
16	Comprehensive income						$ 135,793					
17	Stock options exercised			1,918						2,052		
18	Unearned compensation			3,933					(3,485)	636		
19	Performance shares			686						712		
20	Procomp and Nexus a			37,351		9,487				48,976		
21	Dividends declared				(41,668)					(41,668)		
22	Treasury shares					(1,229)				(1,229)		
23												
24	**Balance**			87,169	$ 691,415	$ (13,644)		$ (5,865)	$ (4,034)	$ 844,395		
25	Net in				136,919		$ 136,919			136,919		
26	Trans						(7,904)			(7,904)		
27	Pensio						1,507			1,507		
28	Unreali						(396)			(396)		
29	Other c						(6,793)	(6,793)				
30	Comprehe						$ 130,126					
31	Stock optio		343	5,444						5,787		
32	Unearned comp		308	5,583					(3,915)	1,976		
33	Performance shares		19	334						353		
34	Dividends declared and pa				(44,271)					(44,271)		
35	Treasury shares					(2,300)				(2,300)		
36												
37	**Balance, December 31, 2000**		$ 90,024	$ 98,530	$ 784,063	$ (15,944)		$ (12,658)	$ (7,949)	$ 936,066		
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)				
43	Comprehensive income						$ 19,105					
44	Stock options exercised	176,395	221	4,860						5,081		
45	Unearned compensation								1,412	1,412		
46	Dividends declared and paid				(45,774)					(45,774)		
47	Treasury shares					(12,780)				(12,780)		
48												
49	**Balance, December 31, 2001**	712,603	$ 90,245	$ 103,390	$ 805,182	$ (28,724)		$ (60,446)	$ (6,537)	$ 903,110		
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AF52

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2	[DOLLARS IN THOUSANDS]											
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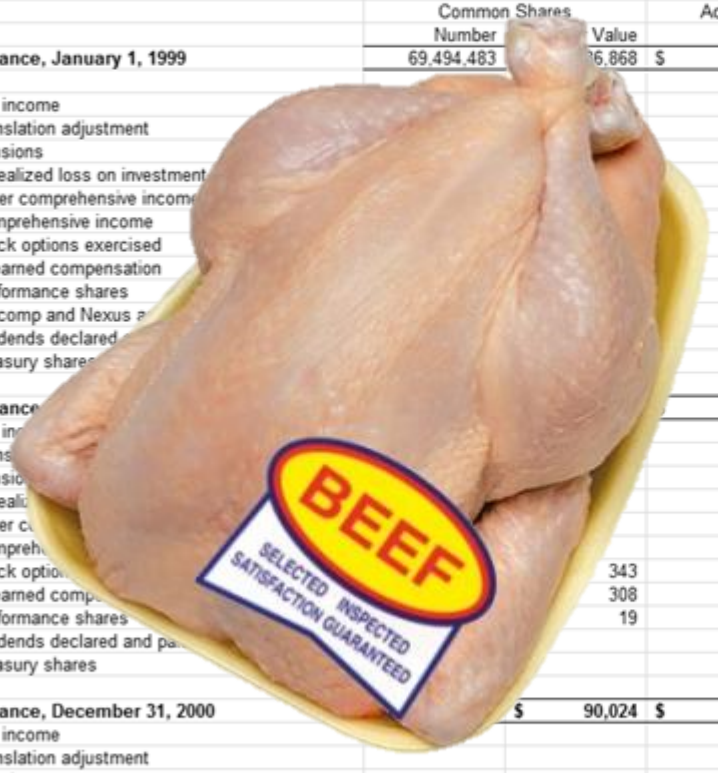

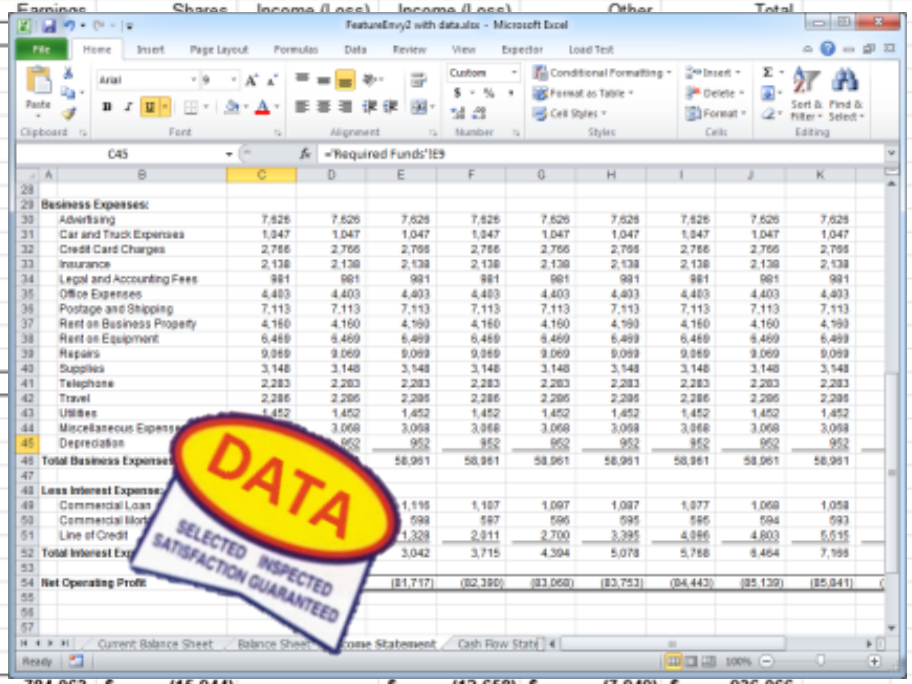


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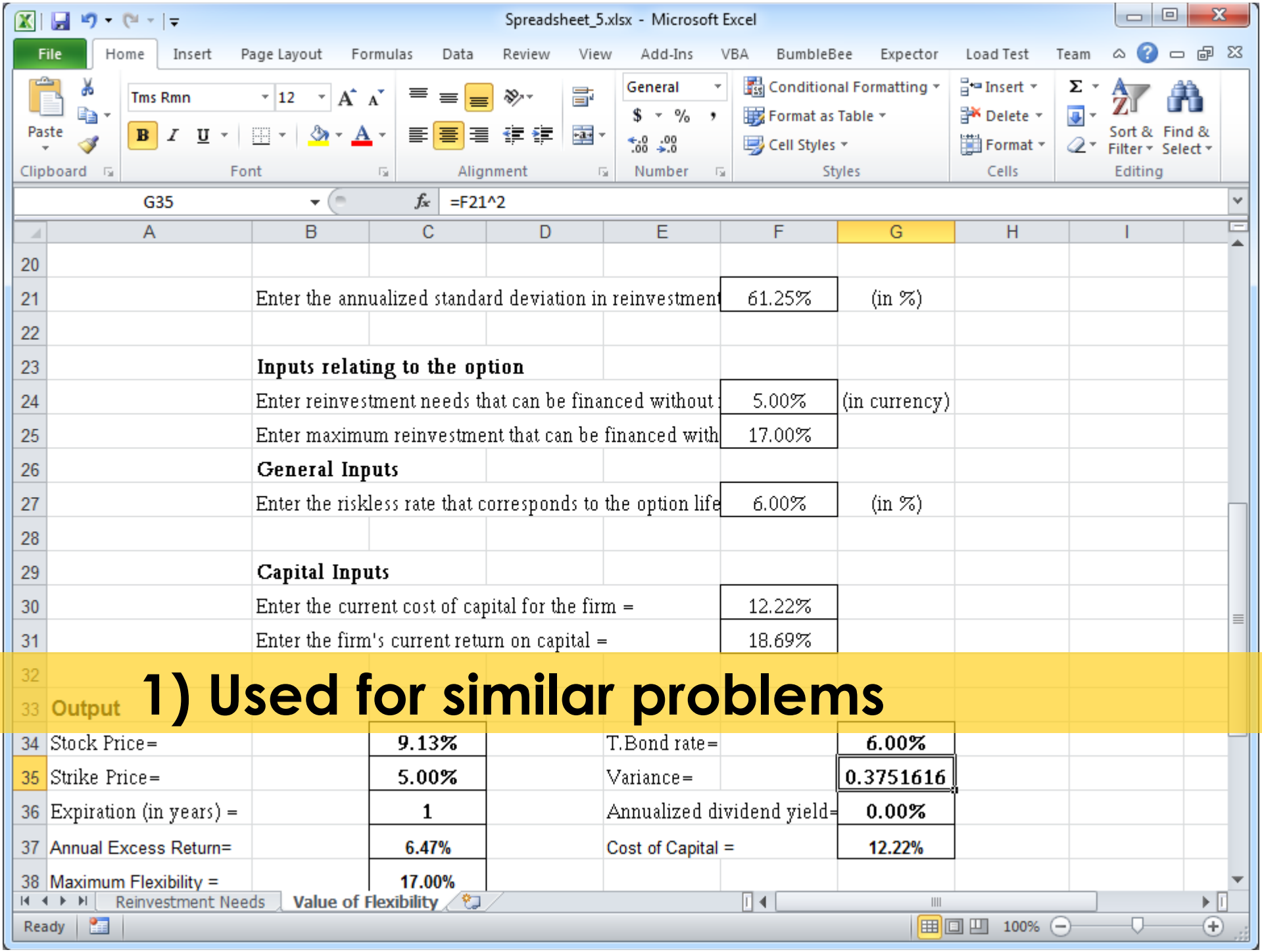
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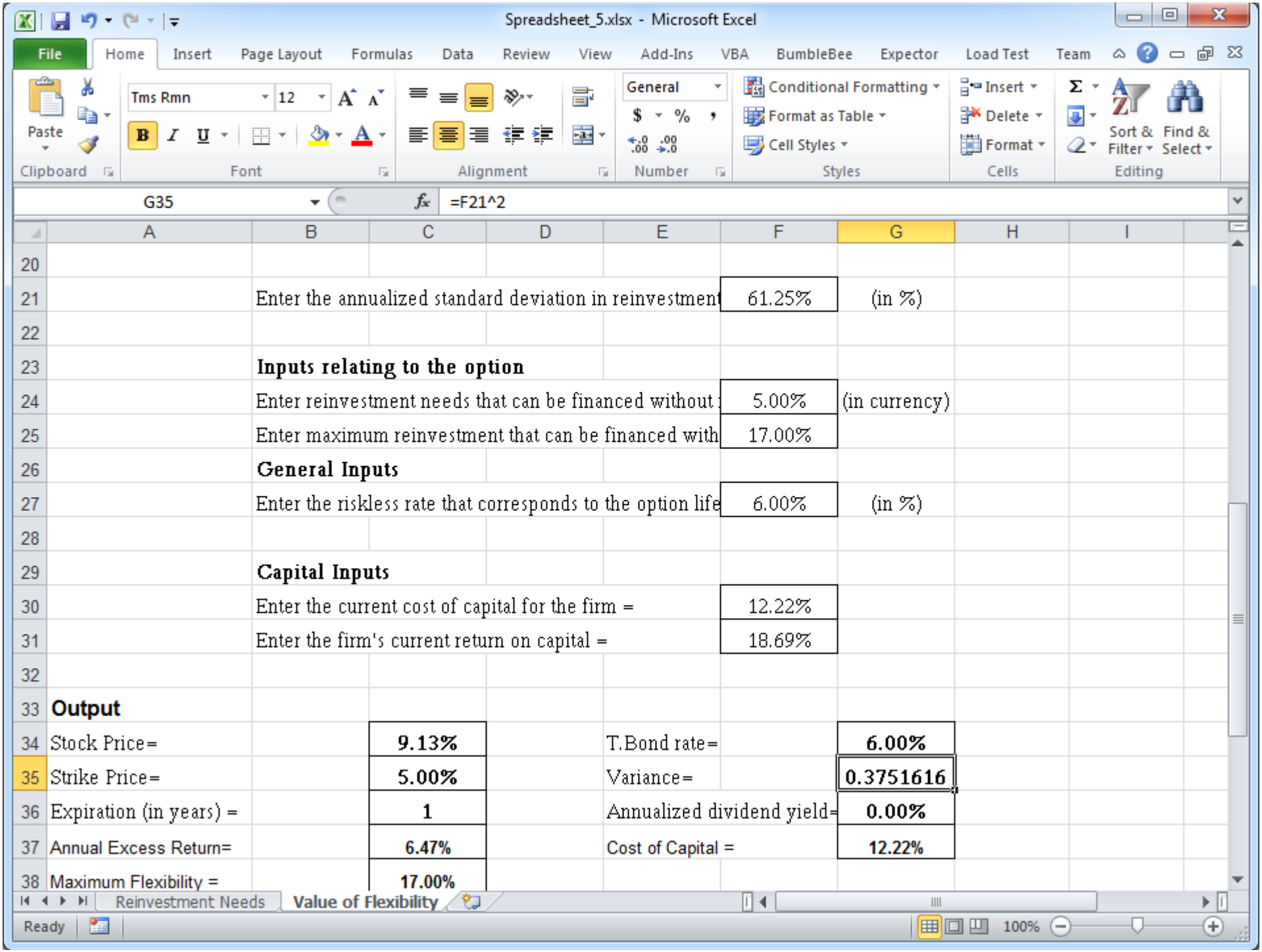
G35
=F21^2
Enter the annualized standard deviation in reinvestment
61.25%
(in %)
Inputs relating to the option
Enter reinvestment needs that can be financed without
5.00%
(in currency)
Enter maximum reinvestment that can be financed with
17.00%
General Inputs
Enter the riskless rate that corresponds to the option life
6.00%
(in %)
Capital Inputs
Enter the current cost of capital for the firm =
12.22%
Enter the firm's current return on capital =
18.69%
1) Used for similar problems
Output
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%
Reinvestment Needs
Value of Flexibility
Ready
100%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G35
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(in currency)
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6.00%
(in %)
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Enter the current cost of capital for the firm =
12.22%
Enter the firm's current return on capital =
18.69%
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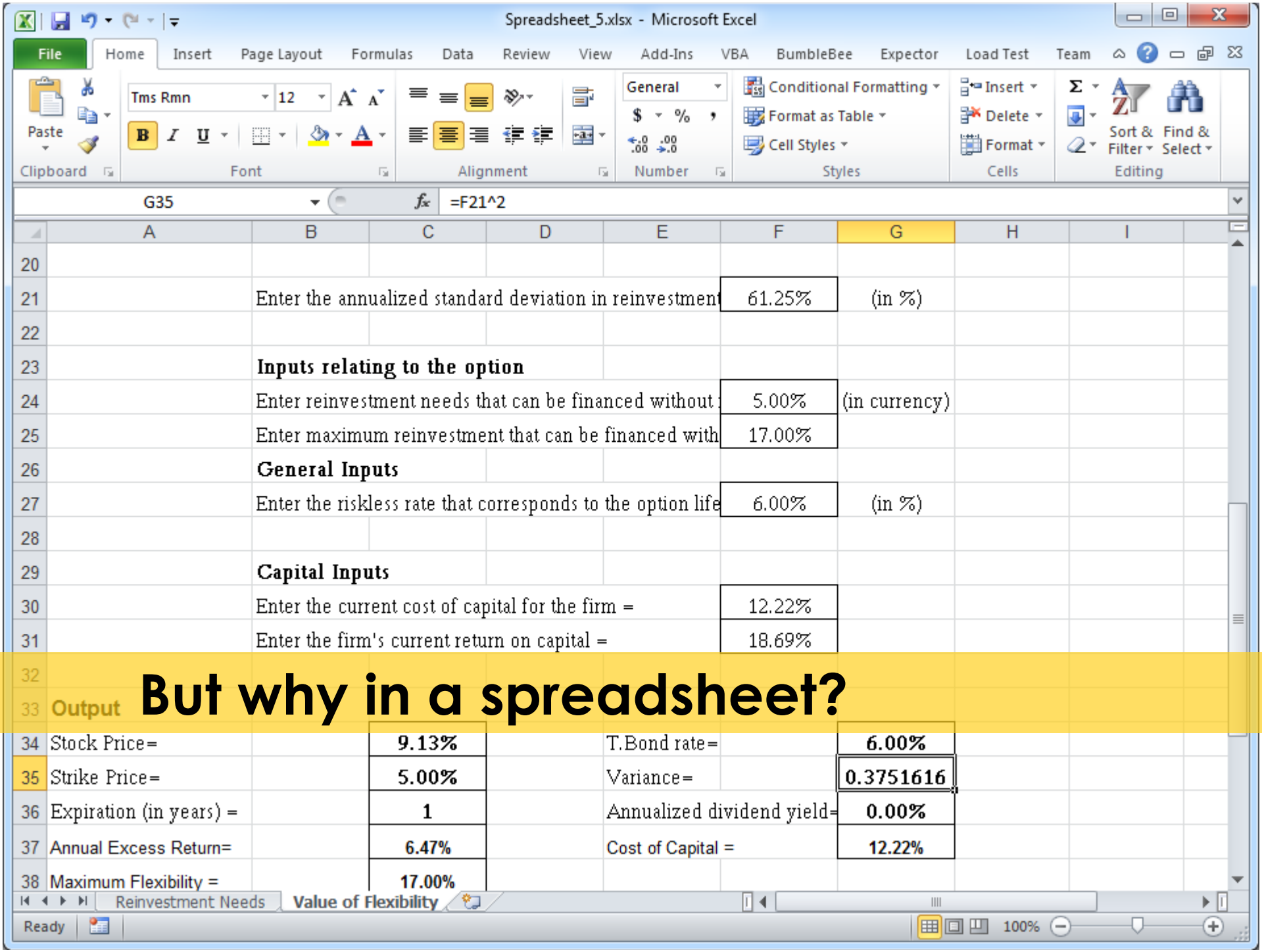
Stock Price=
9.13%
T.Bond rate=
6.00%
Strike Price=
5.00%
Variance=
0.3751616
Expiration (in years) =
1
Annualized dividend yield=
0.00%
Annual Excess Return=
6.47%
Cost of Capital =
12.22%
Maximum Flexibility =
17.00%
Reinvestment Needs
Value of Flexibility
Ready
100%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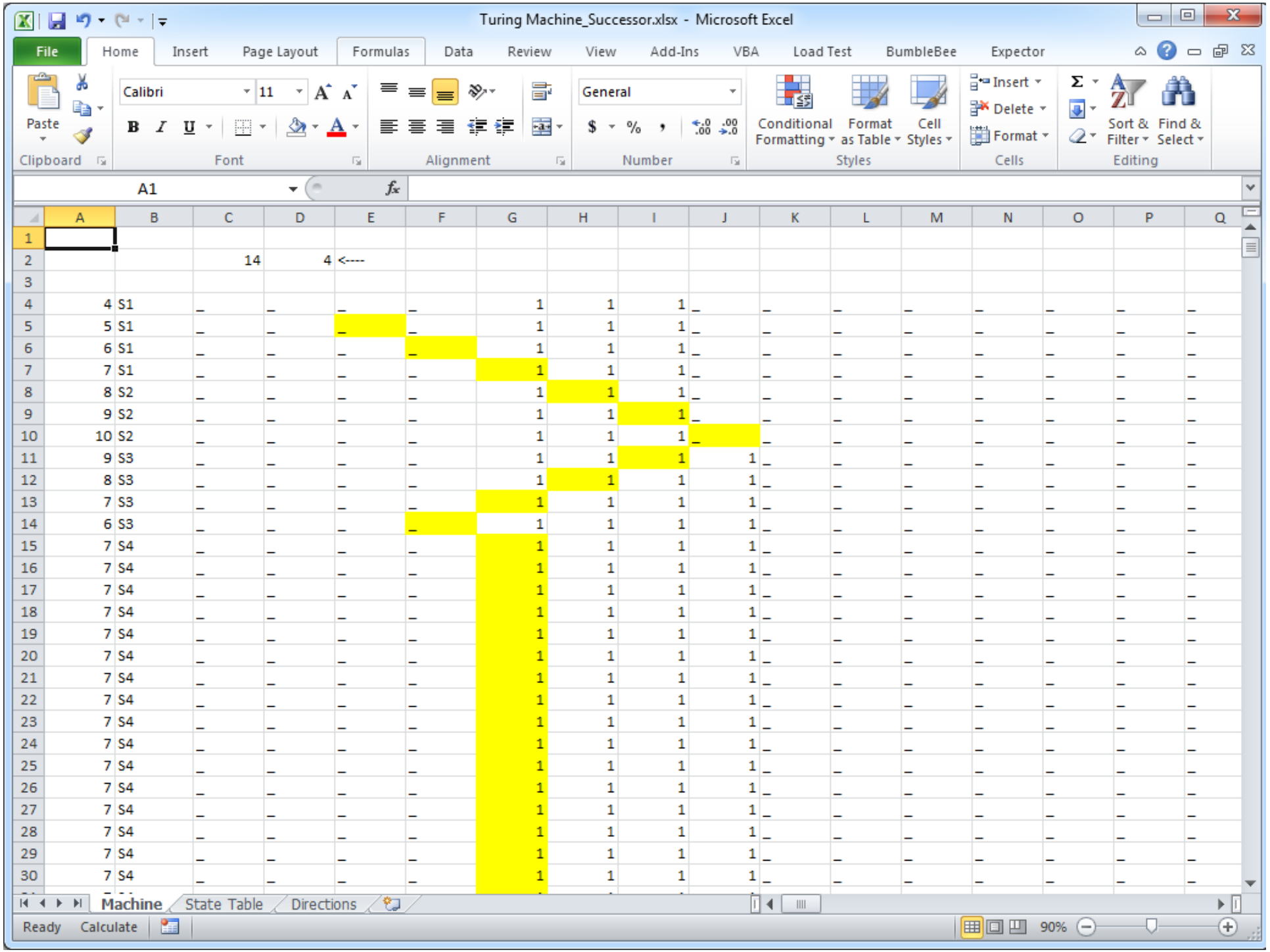
G35 =F21^2
Enter the annualized standard deviation in reinvestment 61.25% (in %)
Inputs relating to the option
Enter reinvestment needs that can be financed without 5.00% (in currency)
Enter maximum reinvestment that can be financed with 17.00%
General Inputs
Enter the riskless rate that corresponds to the option life 6.00% (in %)
Capital Inputs
Enter the current cost of capital for the firm = 12.22%
Enter the firm's current return on capital = 18.69%
But why in a spreadsheet?
Output
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%
Reinvestment Needs Value of Flexibility
Ready 100%



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3																	
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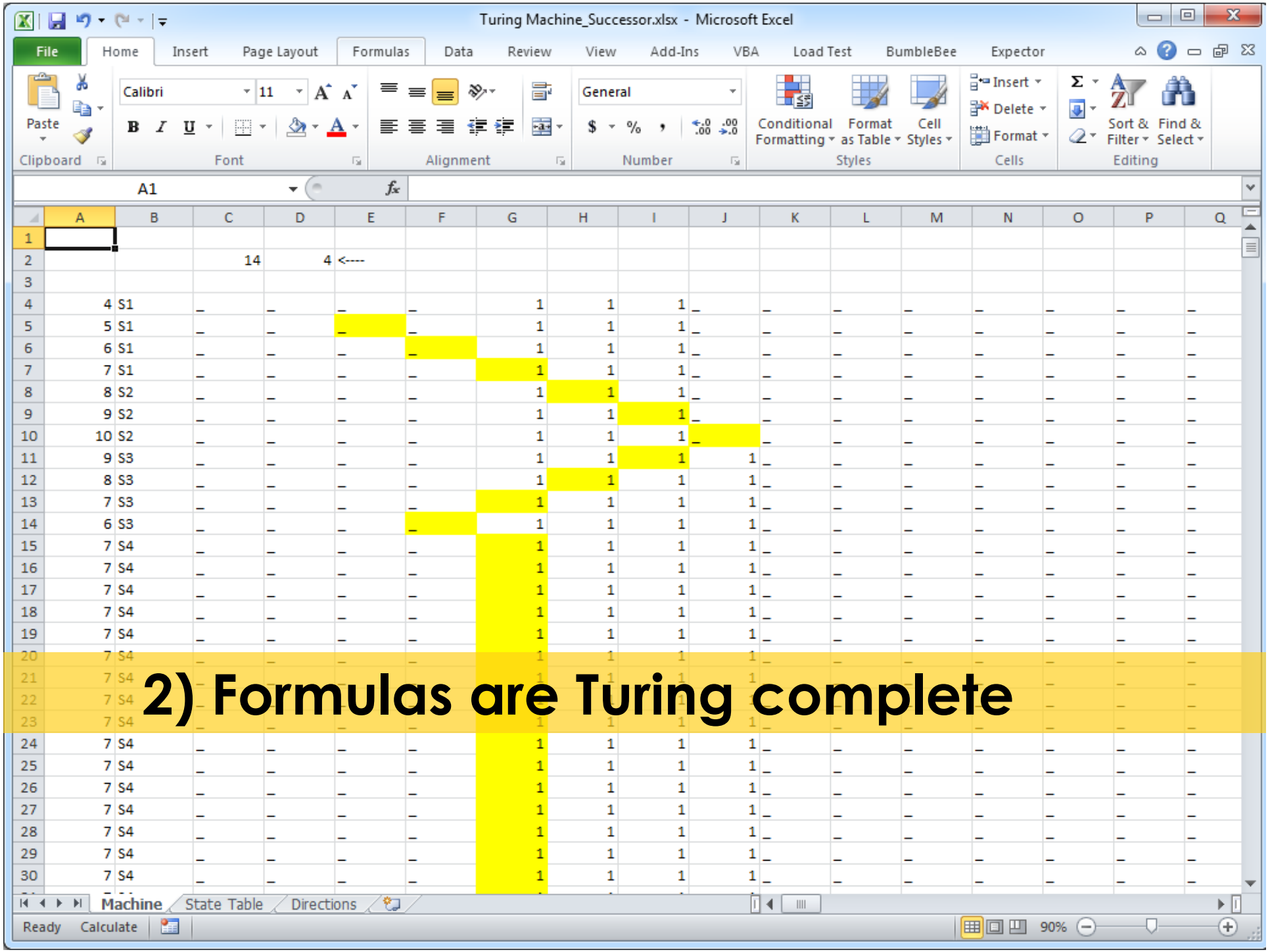
5	5	S1	_	_	_	_	1	1	1	_	_	_	_	_	_	_	_
6	6	S1	_	_	_	_	1	1	1	_	_	_	_	_	_	_	_
7	7	S1	_	_	_	_	1	1	1	_	_	_	_	_	_	_	_
8	8	S2	_	_	_	_	1	1	1	_	_	_	_	_	_	_	_
9	9	S2	_	_	_	_	1	1	1	_	_	_	_	_	_	_	_
10	10	S2	_	_	_	_	1	1	1	_	_	_	_	_	_	_	_
11	9	S3	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
12	8	S3	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
13	7	S3	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
14	6	S3	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
15	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
16	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
17	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
18	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
19	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
20	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
21	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
22	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
23	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
24	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
25	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
26	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
27	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
28	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
29	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_
30	7	S4	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_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2) Formulas are Turing complete

boing boing

Implementing a Turing machine in Excel

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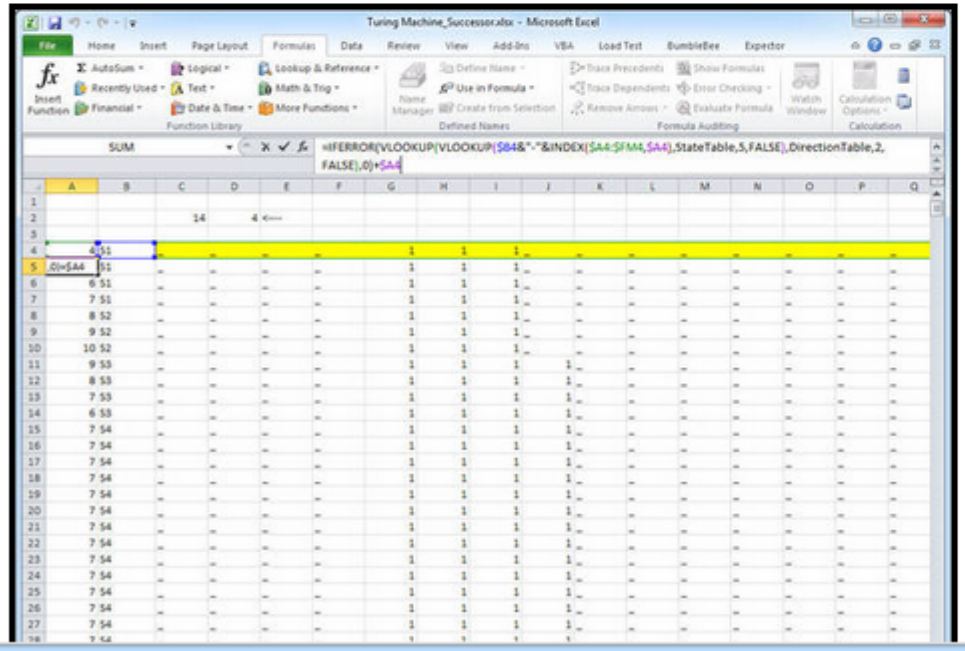

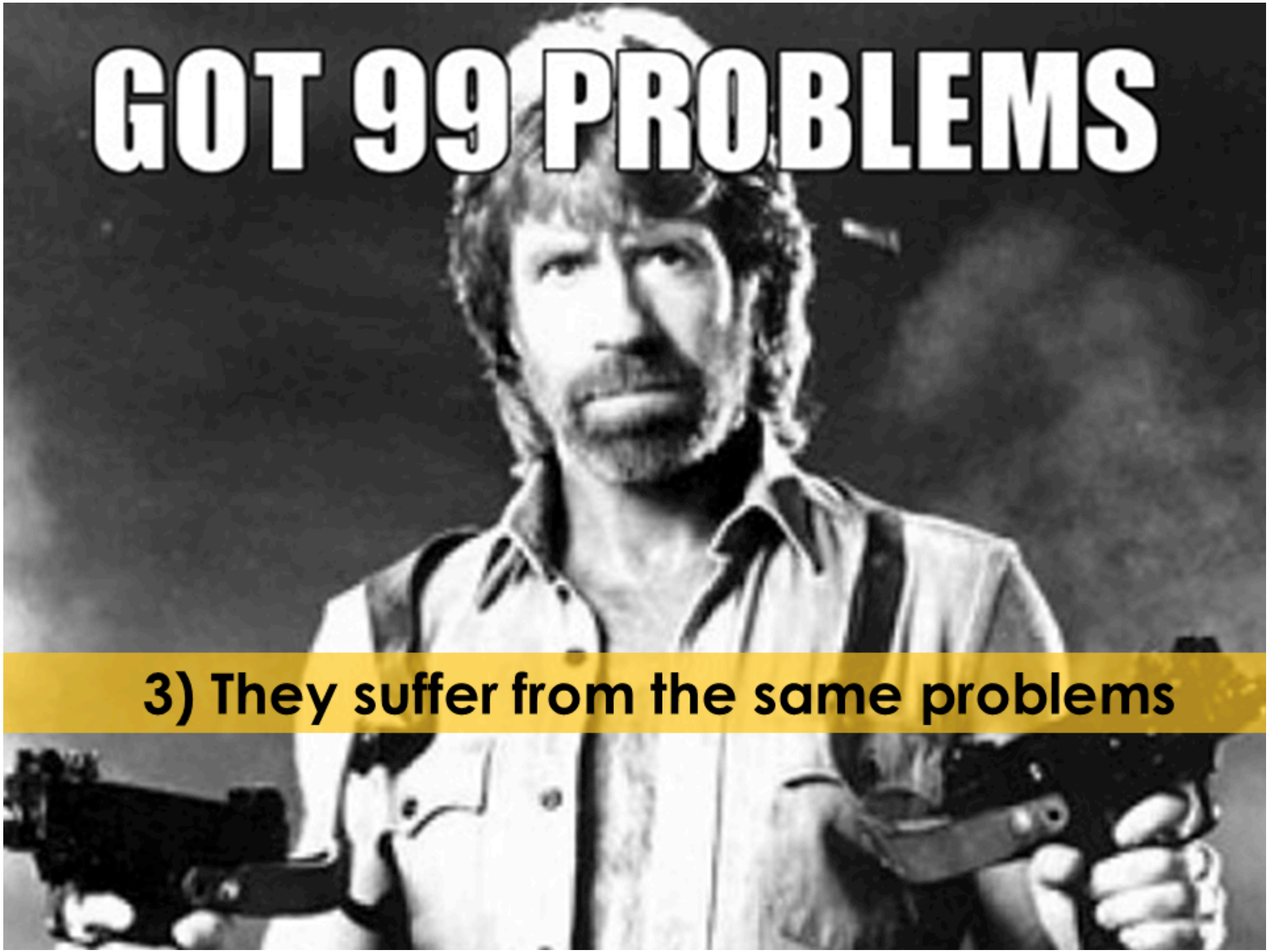
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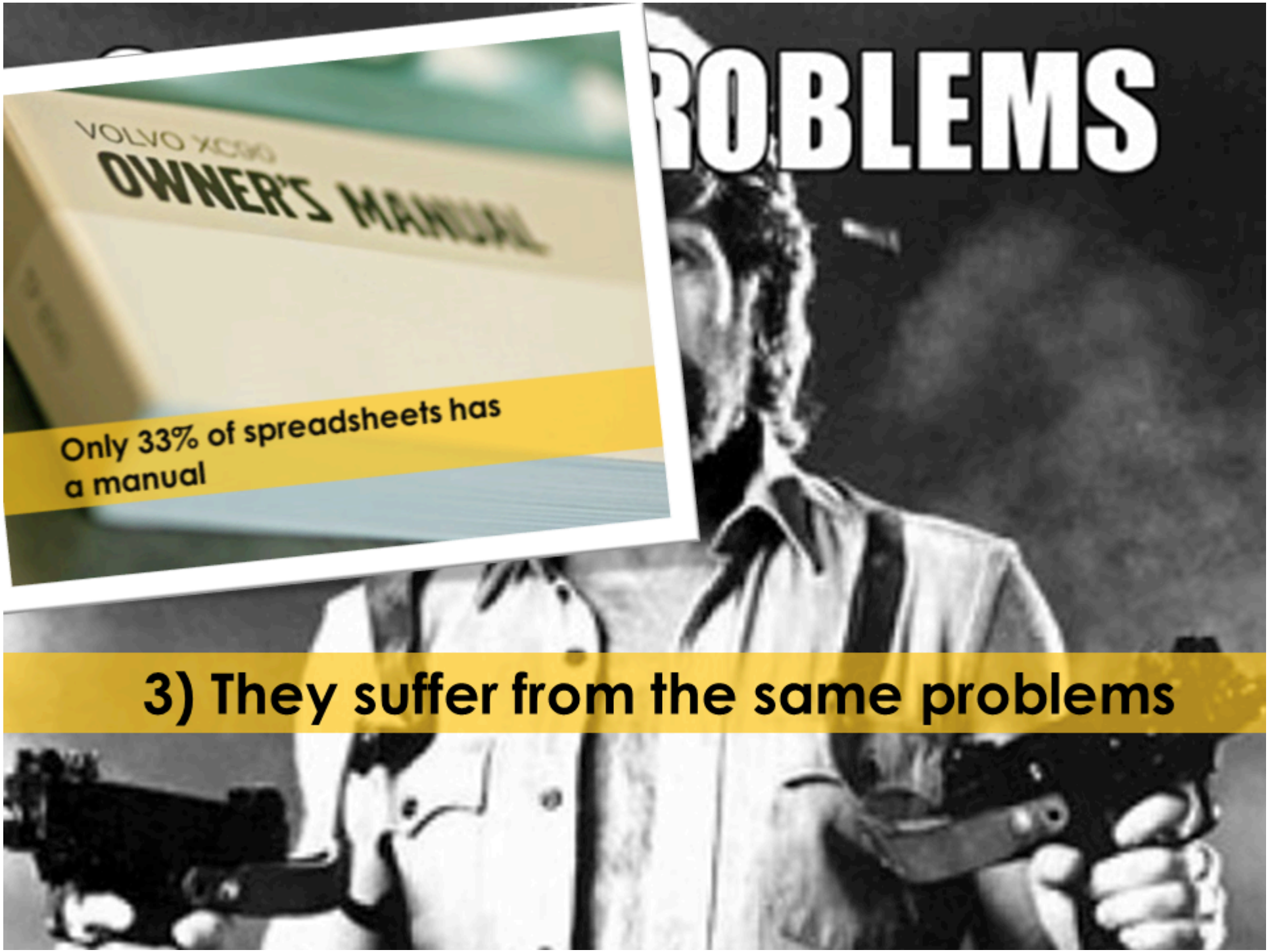
3) They suffer from the same problems


VOLVO XC90
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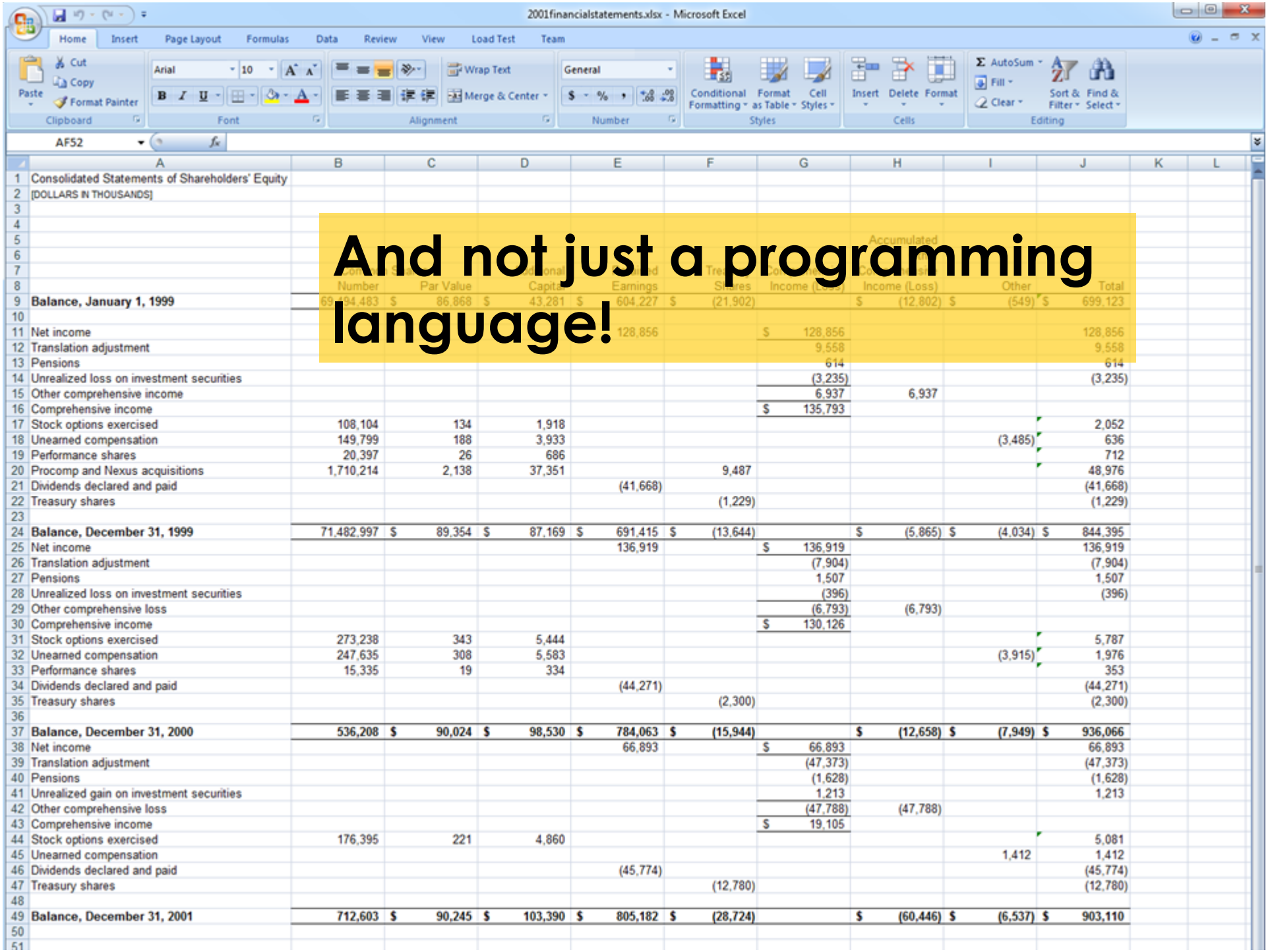
Only 33% of spreadsheets has a manual
ROBLEMS
3) They suffer from the same problems


VOLVO XC
OWNE
Only 33% o
a manual
Average sheet is used by 12 different people
PROBLEMS
3) They suffer from the same problems


Only 33% o
a manual
Average sheet is us
people
Spreadsheets can have a long life,
5 years on average
3) They suffer from the same problems

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


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



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20	Procomp and Nexus acquisitions	1,710,214	2,138	37,351		9,487				48,976		
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23												
24	**Balance, December 31, 1999**	71,482,997	$ 89,354	$ 87,169	$ 691,415	$ (13,644)		$ (5,865)	$ (4,034)	$ 844,395		
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29	Other comprehensive loss						(6,793)	(6,793)				
30	Comprehensive income						$ 130,126					
31	Stock options exercised	273,238	343	5,444						5,787		
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36												
37	**Balance, December 31, 2000**	**536,208**	**$ 90,024**	**$ 98,530**	**$ 784,063**	**$ (15,944)**		**$ (12,658)**	**$ (7,949)**	**$ 936,066**		
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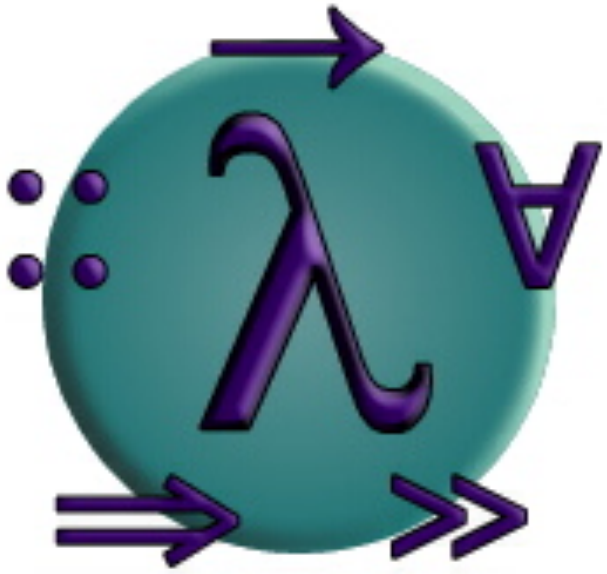
50												
51												


The next language to learn
Resistance is futile!

live programming

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

    drawSky();
    drawMountains();
    drawTree();
}


//----------------------------------------------------------
//
//  sky
//

function drawSky () {
    ctx.save();

    var gradient = ctx.createLinearGradient(0,0,0,canvasHeight);
    gradient.addColorStop(0, "#b4e0fe");
    gradient.addColorStop(1, "#d3f8ff");

    ctx.fillStyle = gradient;
    ctx.fillRect(0,0,canvasWidth,canvasHeight);

    ctx.restore();
}



//----------------------------------------------------------
//
//  mountains
//

function drawMountains () {
    resetRandom();

    drawMountain(130, "#8bb2bb");
    drawMountain(50, "#618087");
}
```

pure functional



Haskell

A Purely Functional Language

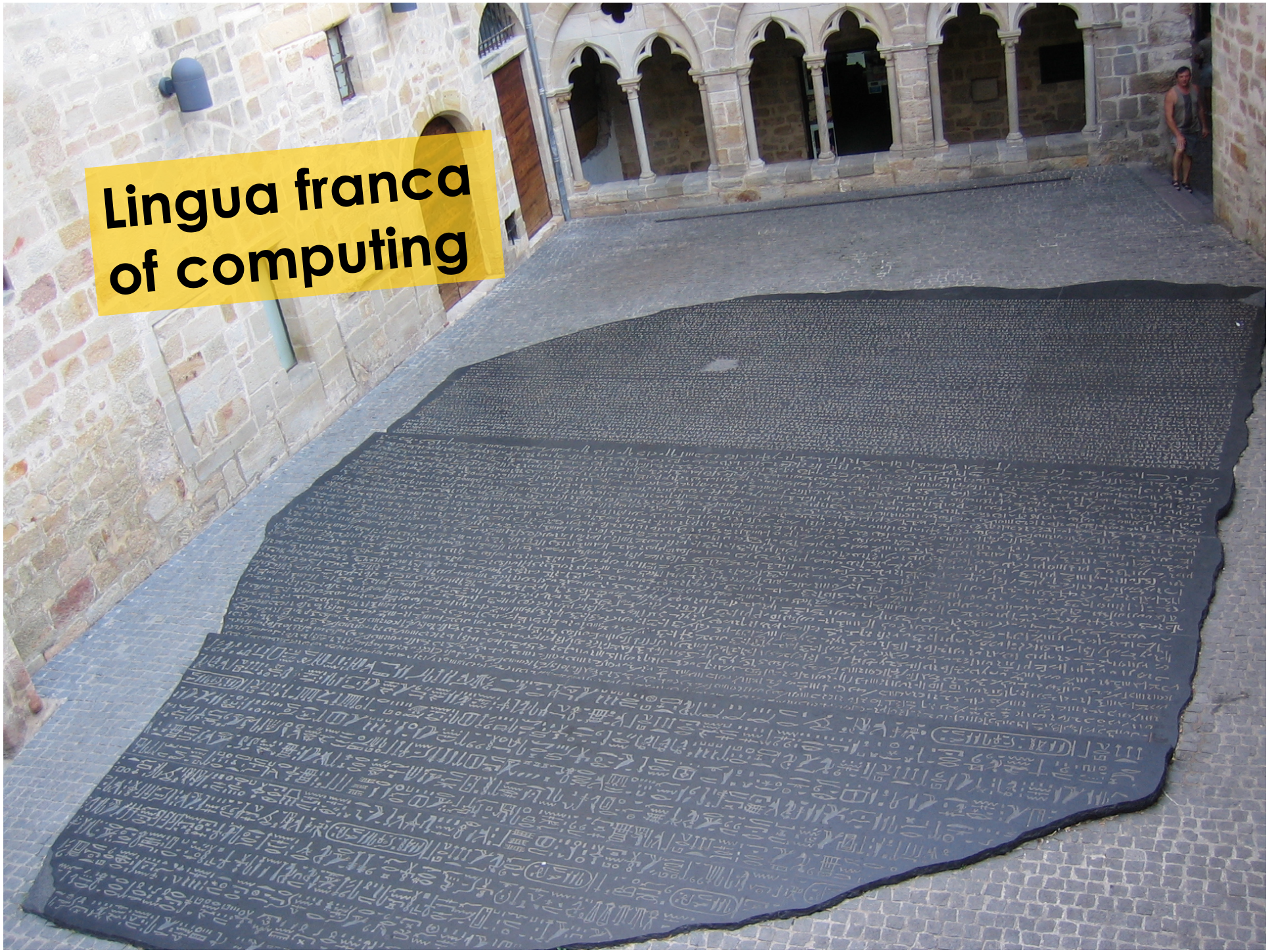
featuring static typing, higher-order functions,
polymorphism, type classes and monadic effects

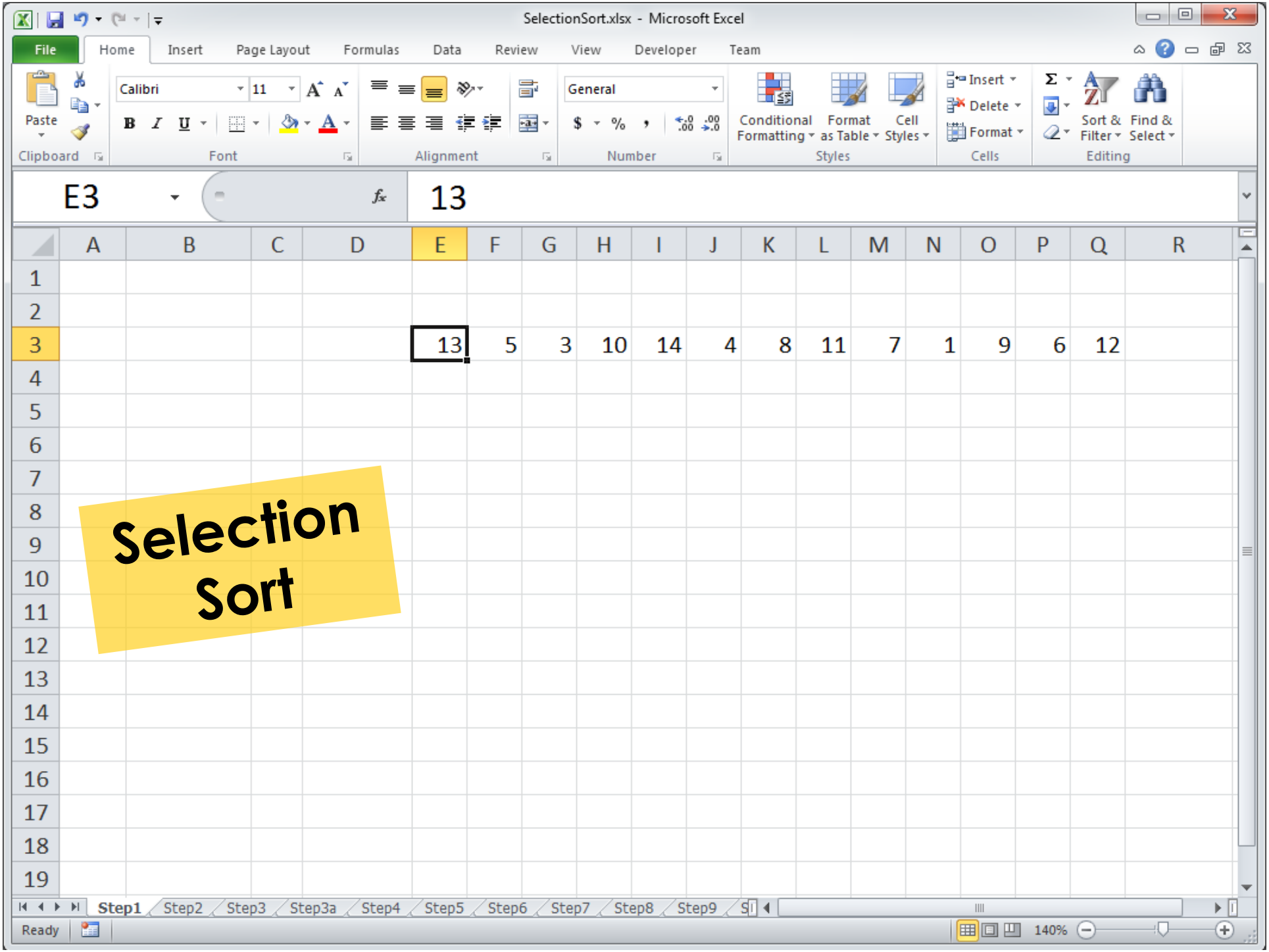
pure functional

Excel

A Purely Functional Language

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


Lingua franca
of computing


SelectionSort.xlsx - Microsoft Excel
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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
2
3 13 5 3 10 14 4 8 11 7 1 9 6 12
4
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9
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Selection Sort
Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9
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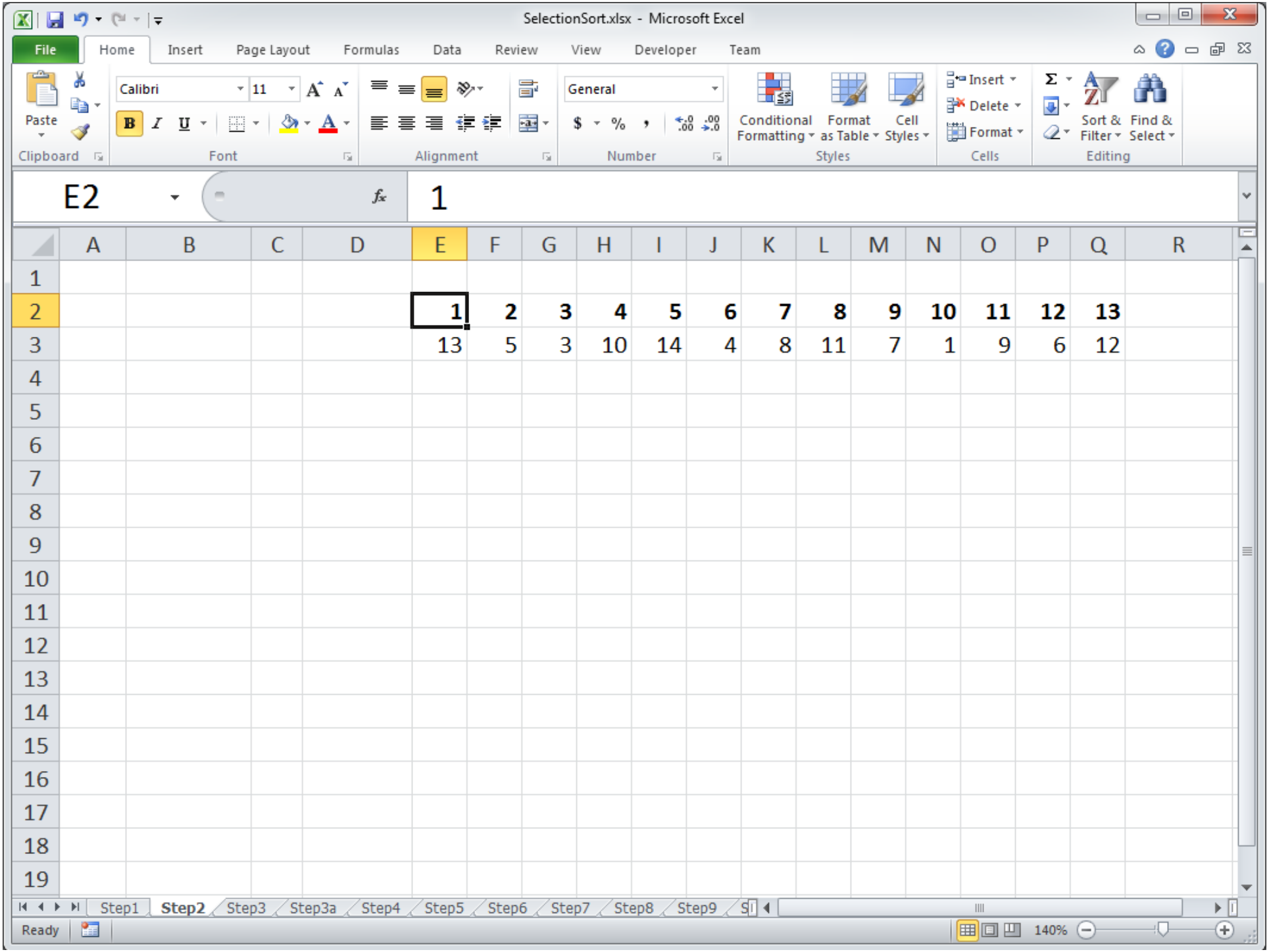
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Editing
E2
1
A B C D E F G H I J K L M N O P Q R
1
2 1 2 3 4 5 6 7 8 9 10 11 12 13
3 13 5 3 10 14 4 8 11 7 1 9 6 12
4
5
6
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Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9
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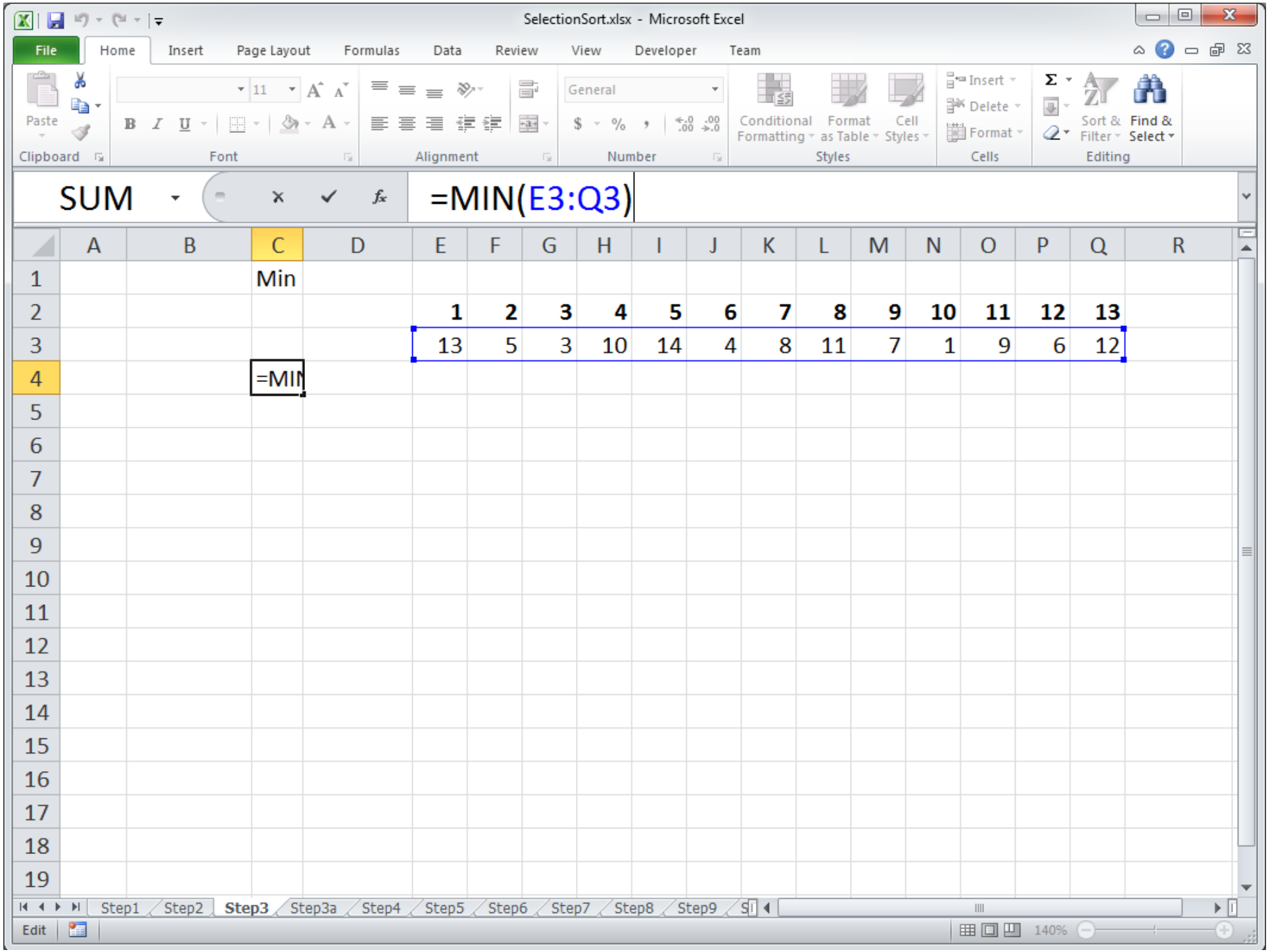
SelectionSort.xlsx - Microsoft Excel
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SUM
=MIN(E3:Q3)
Min
=MIN
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
Step1
Step2
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Step9
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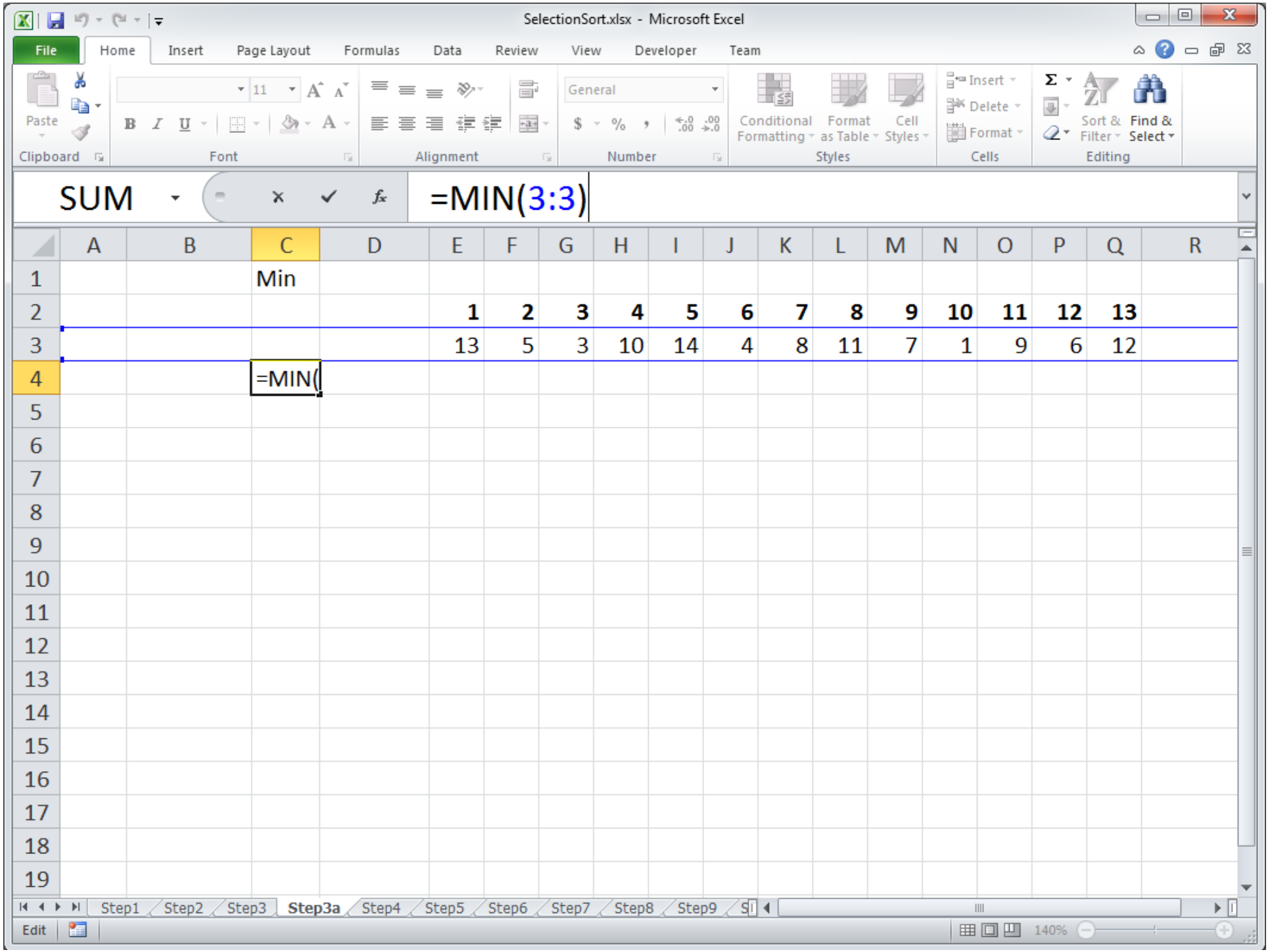
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Format as Table
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Styles
Insert
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Format
Cells
Sort & Filter
Find & Select
Editing
SUM
=MIN(3:3)
Min
=MIN(
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9
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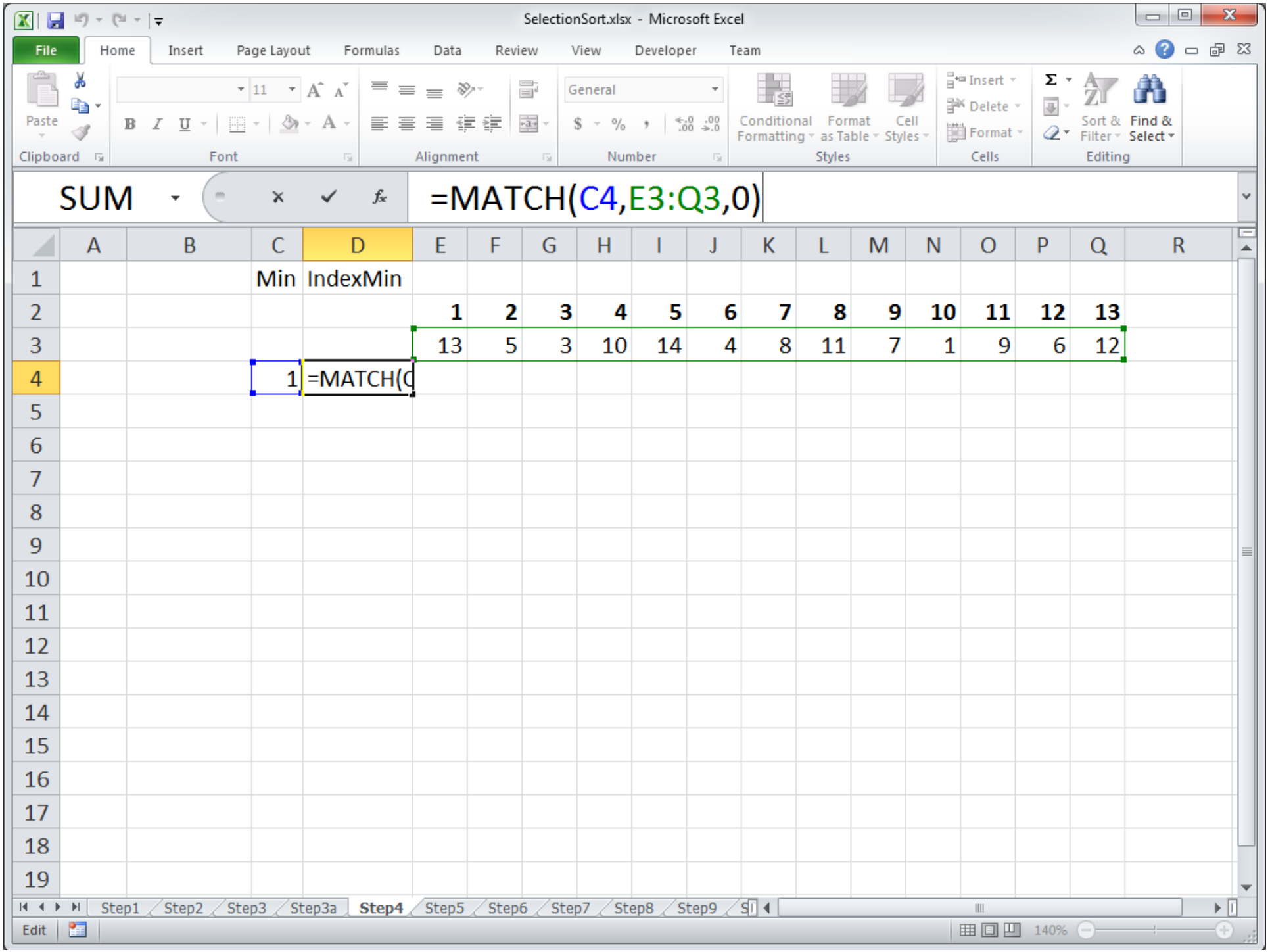
SelectionSort.xlsx - Microsoft Excel
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SUM
=MATCH(C4,E3:Q3,0)
Min
IndexMin
1
2
3
4
5
6
7
8
9
10
11
12
13
13
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14
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=MATCH(C
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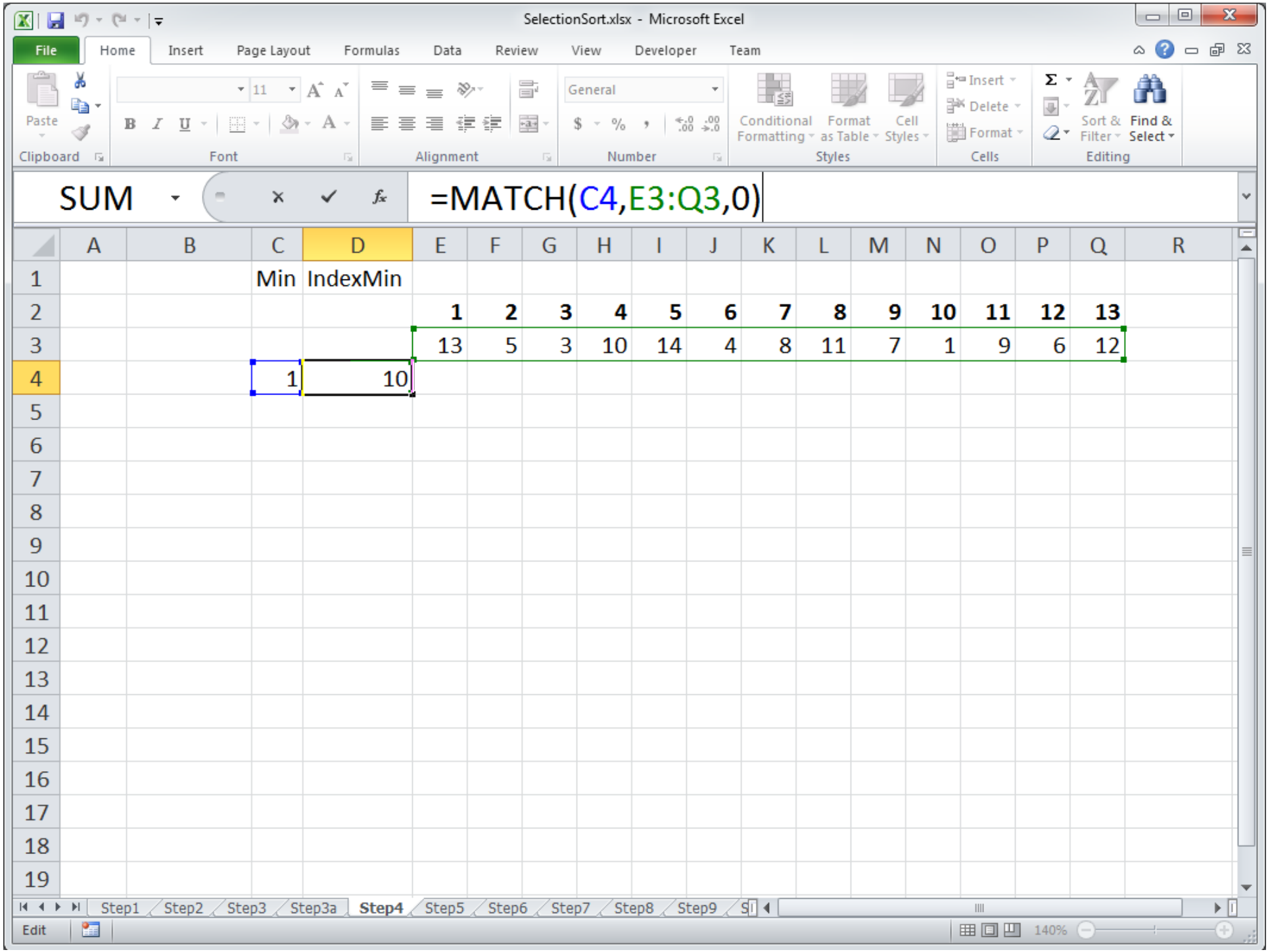
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Editing
SUM
=MATCH(C4,E3:Q3,0)
Min
IndexMin
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13 5 3 10 14 4 8 11 7 1 9 6 12
1
10
Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9
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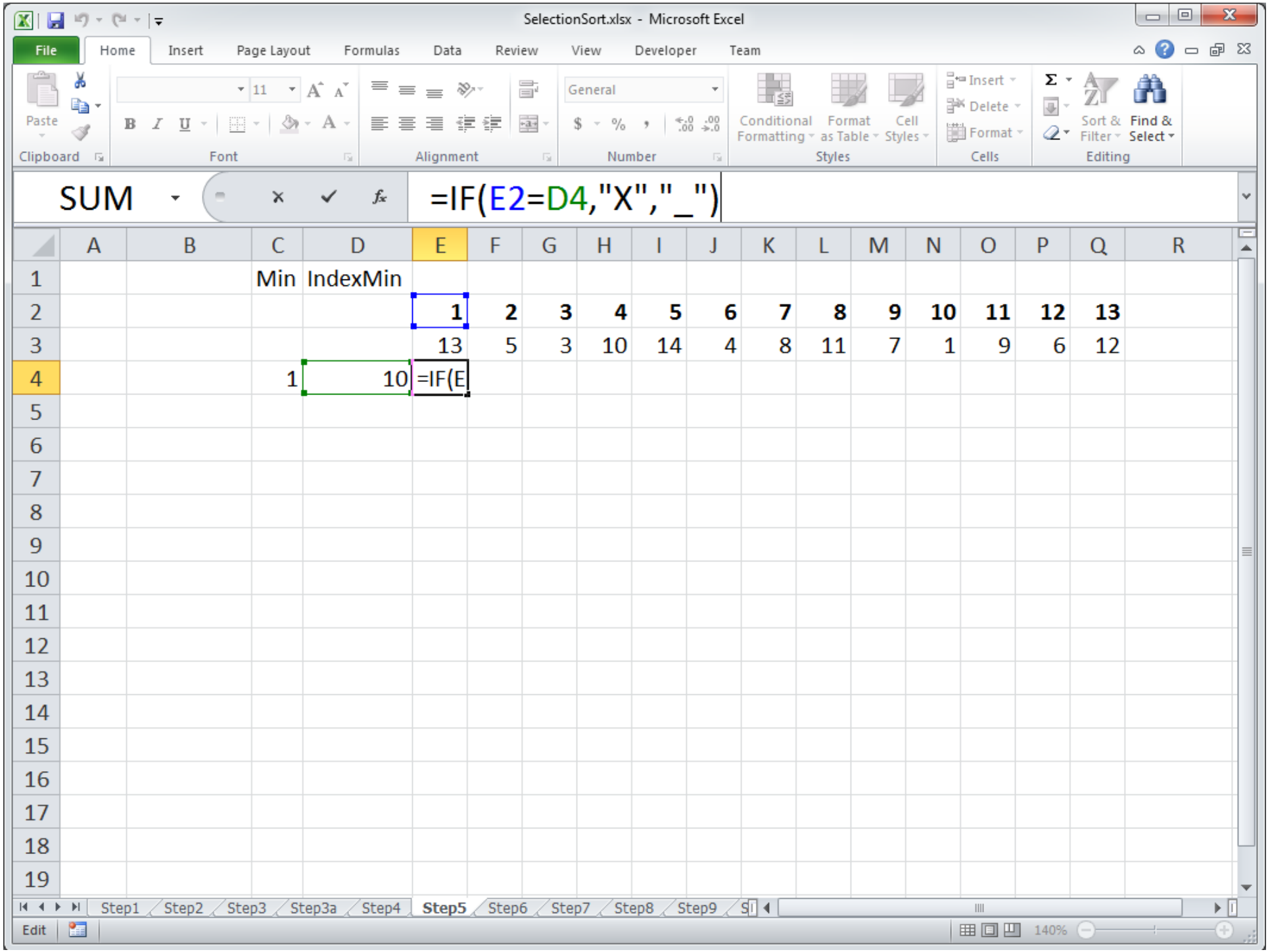
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Find & Select
Editing
SUM
=IF(E2=D4,"X","_")
Min
IndexMin
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
1
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=IF(E
Step1
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Step3a
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Step9
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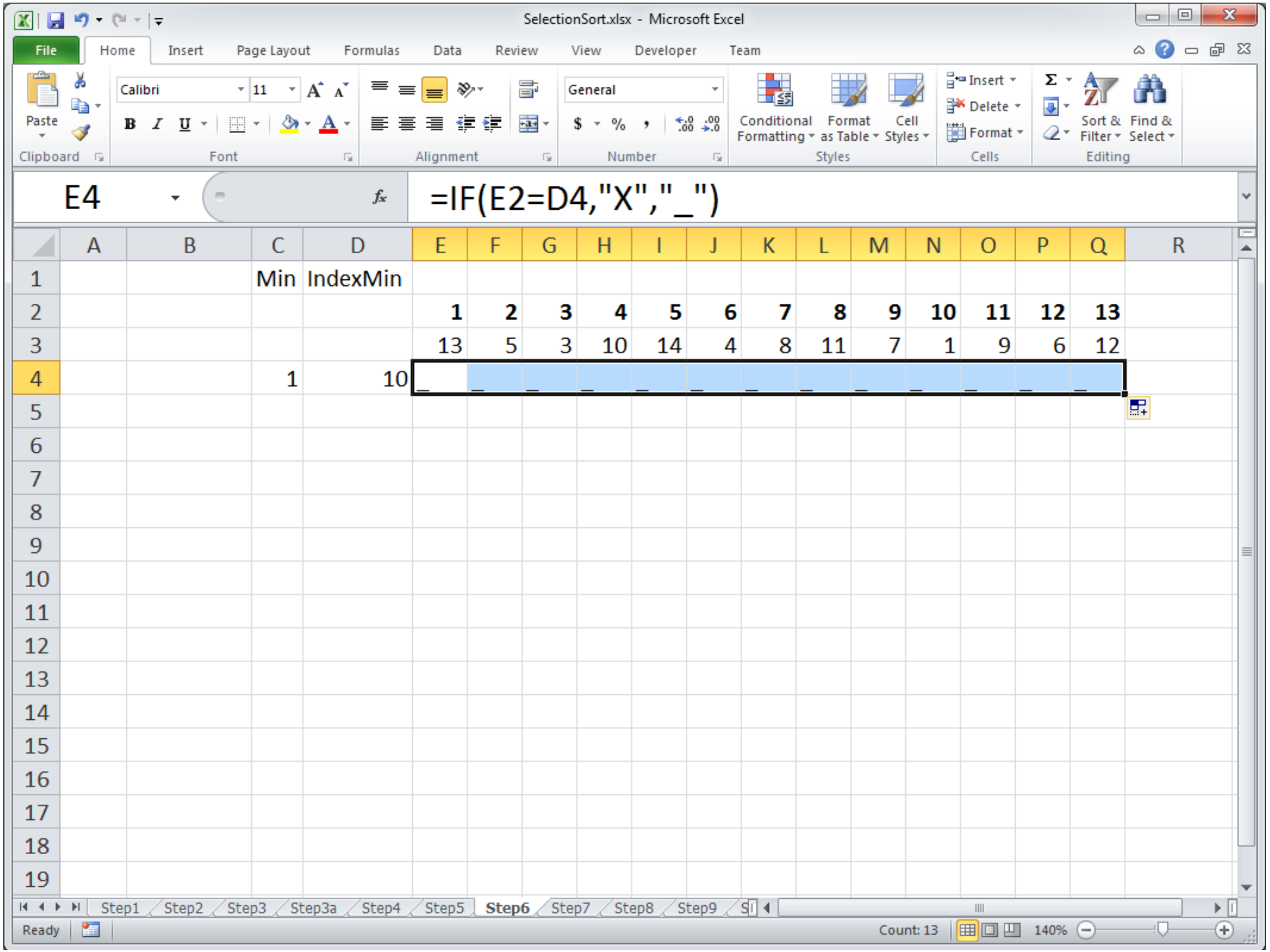
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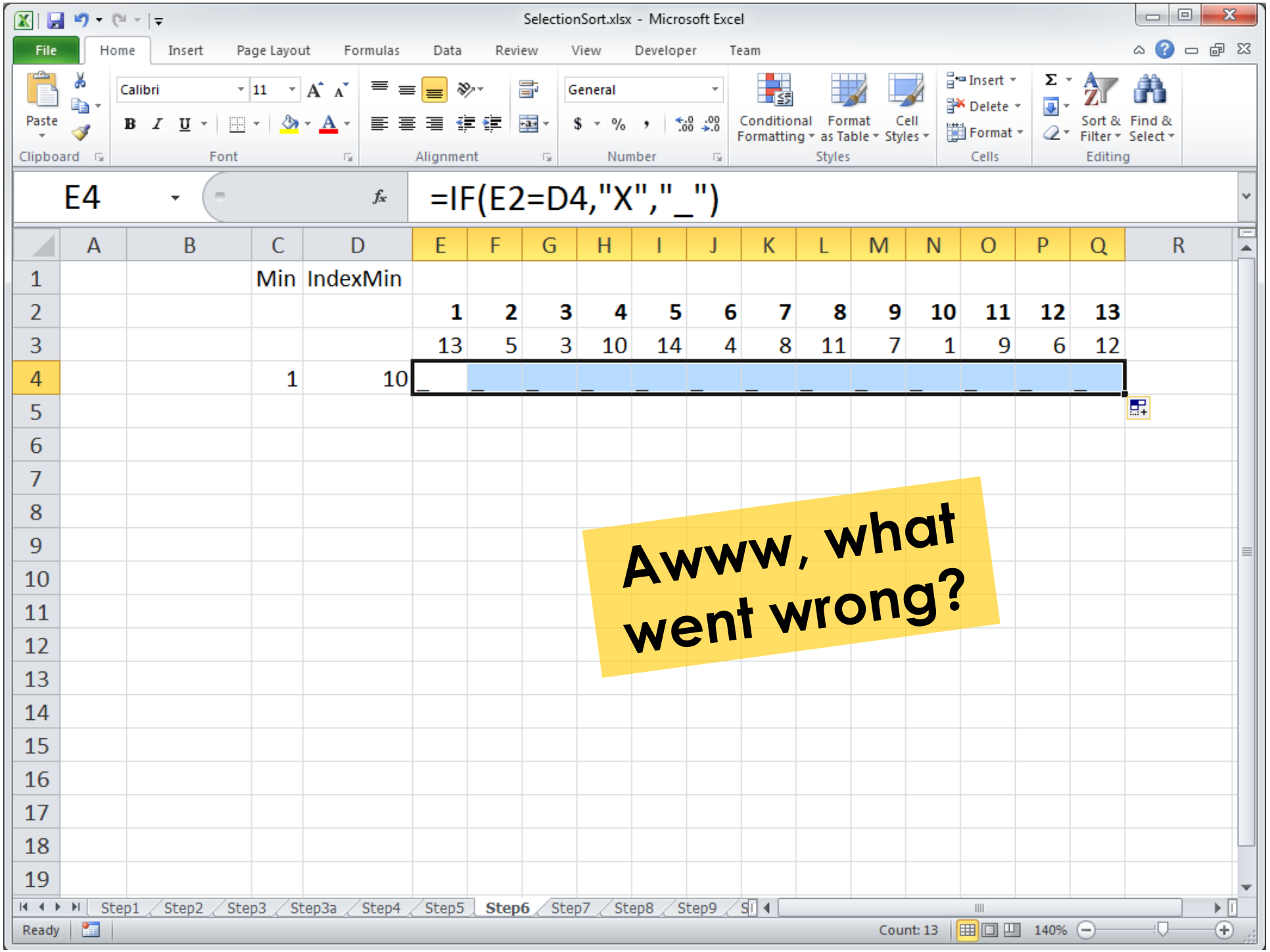
Editing
E4
=IF(E2=D4,"X","_")
Min
IndexMin
1
10
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
Step1
Step2
Step3
Step3a
Step4
Step5
Step6
Step7
Step8
Step9
Ready
Count: 13
140%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E4
=IF(E2=D4,"X","_")
Min
IndexMin
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10
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
_ _ _ _ _ _ _ _ _ _ _ _ _
Awww, what went wrong?
Step1
Step2
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Step9
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Count: 13
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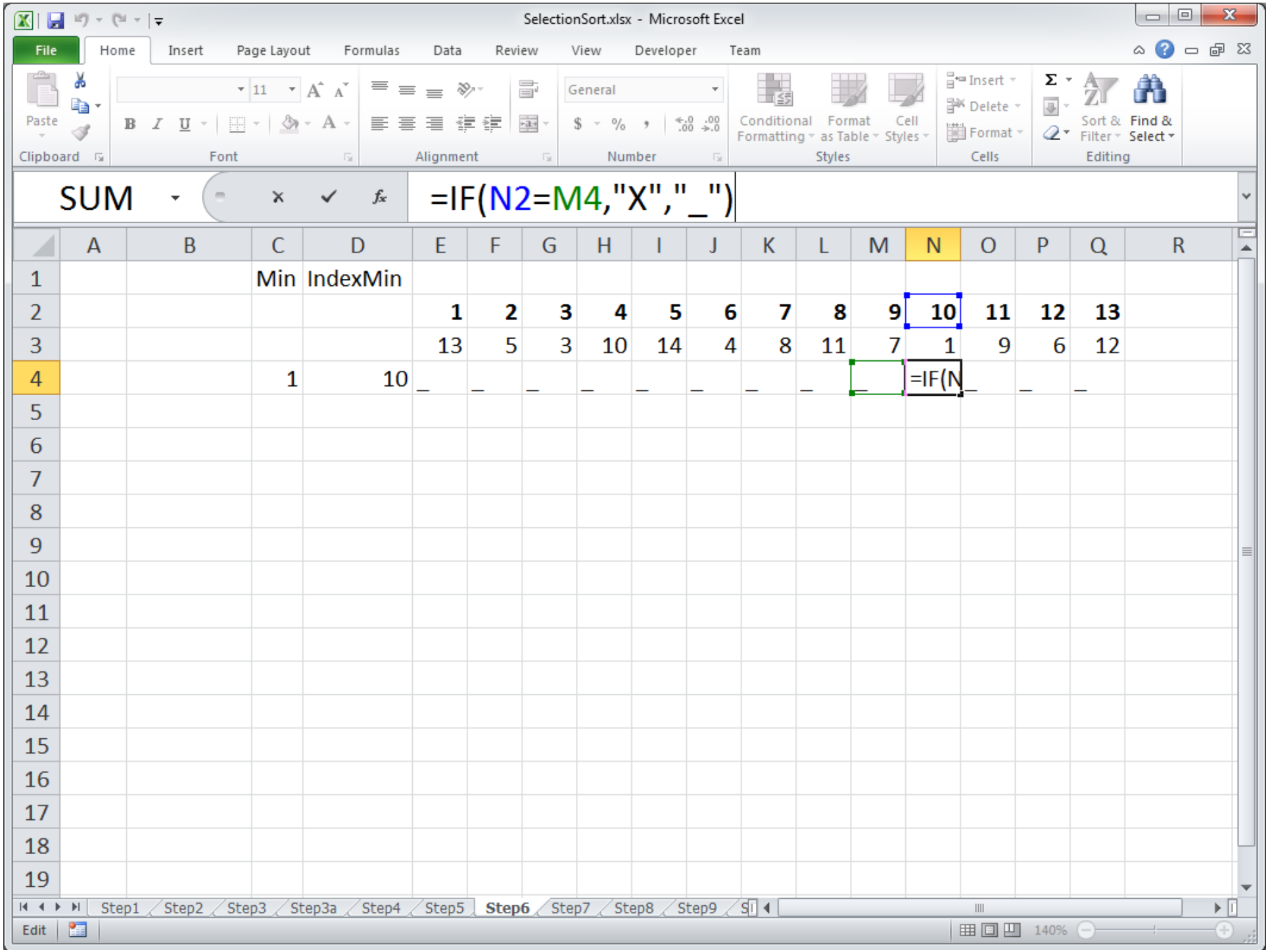
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Editing
SUM
=IF(N2=M4,"X","_")
Min
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1
10
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
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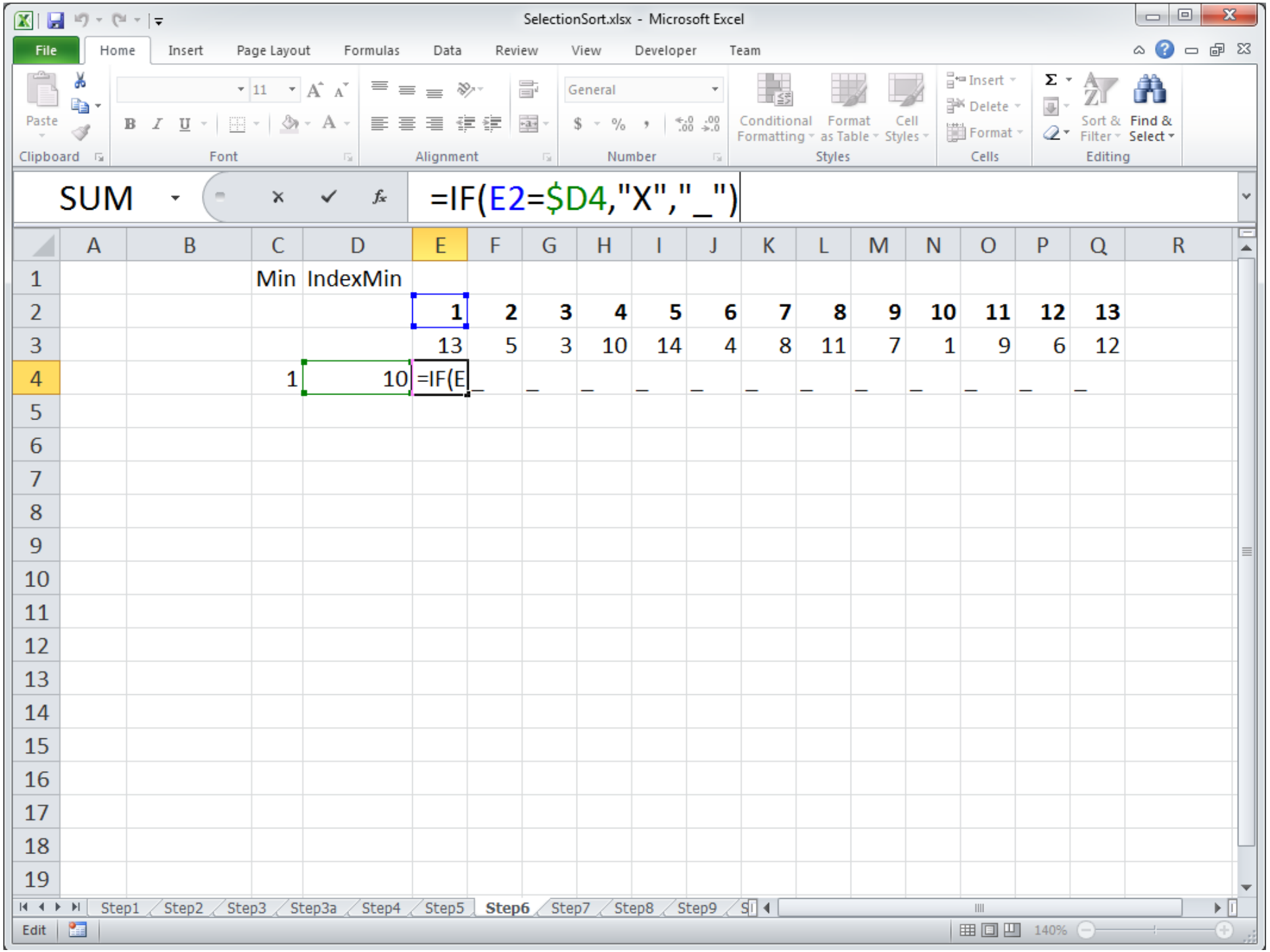
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=IF(E
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13 5 3 10 14 4 8 11 7 1 9 6 12
Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9
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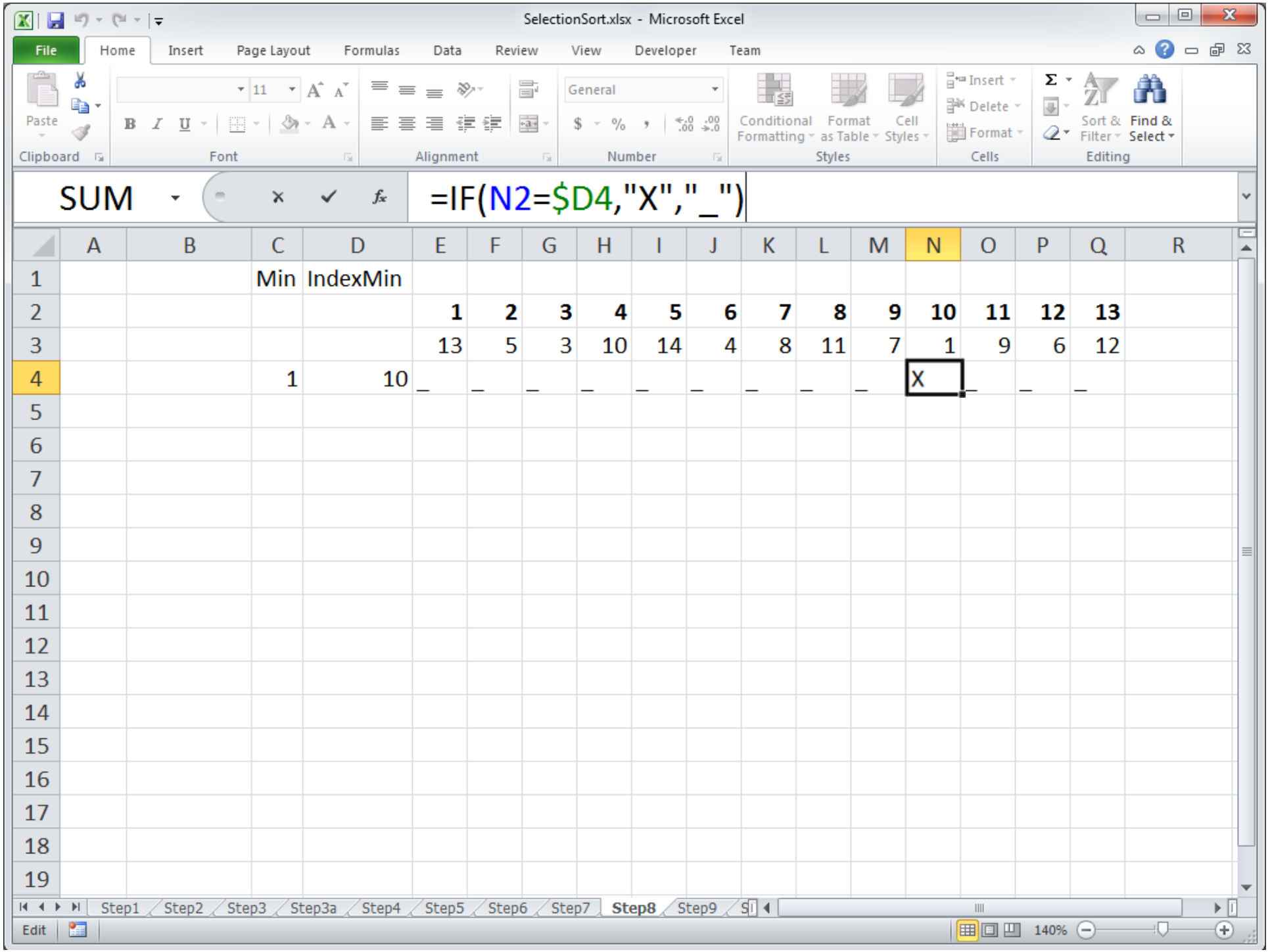
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Editing
SUM
=IF(N2=$D4,"X","_")
Min
IndexMin
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10
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
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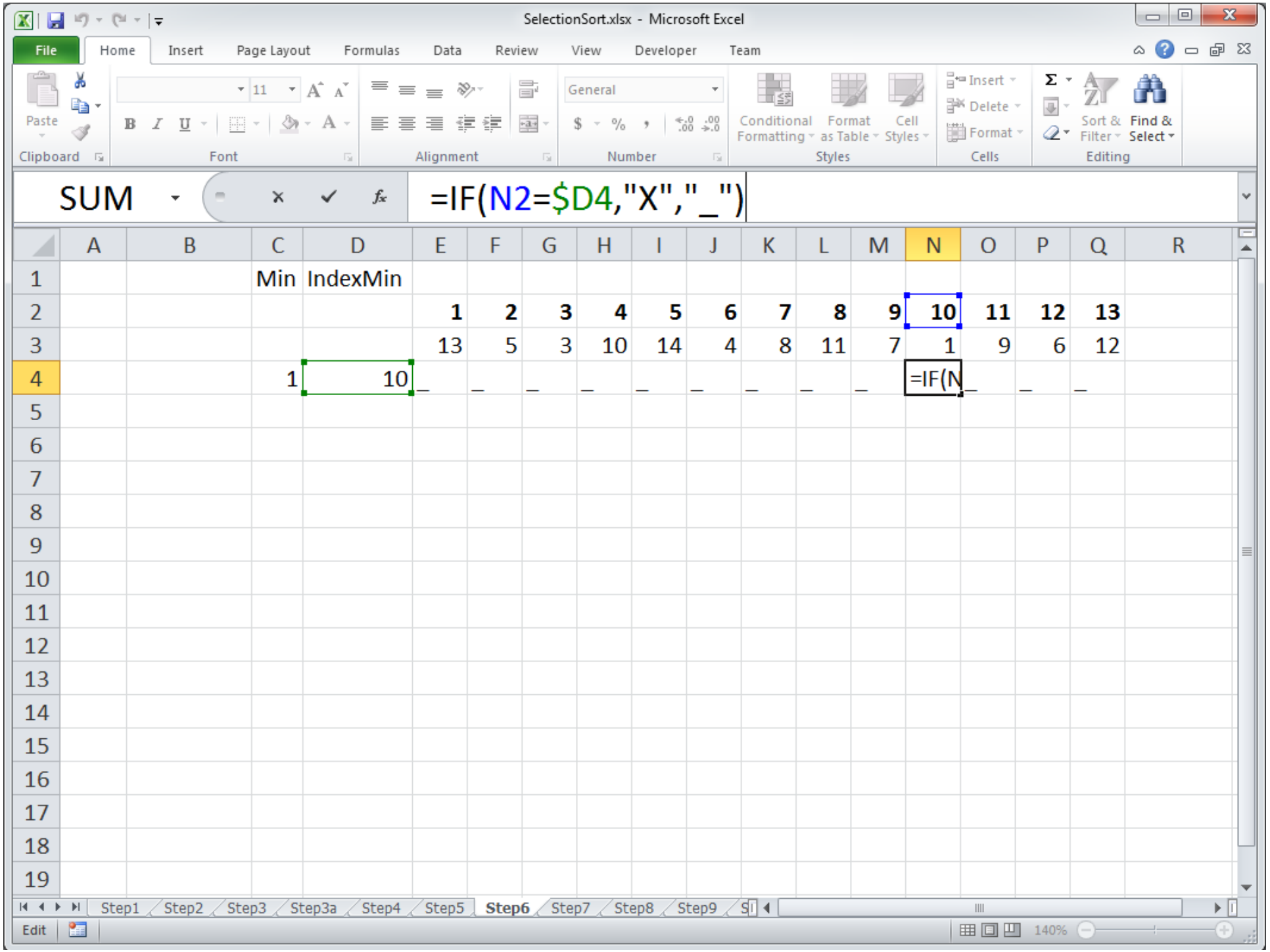
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Min
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1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
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Step3a
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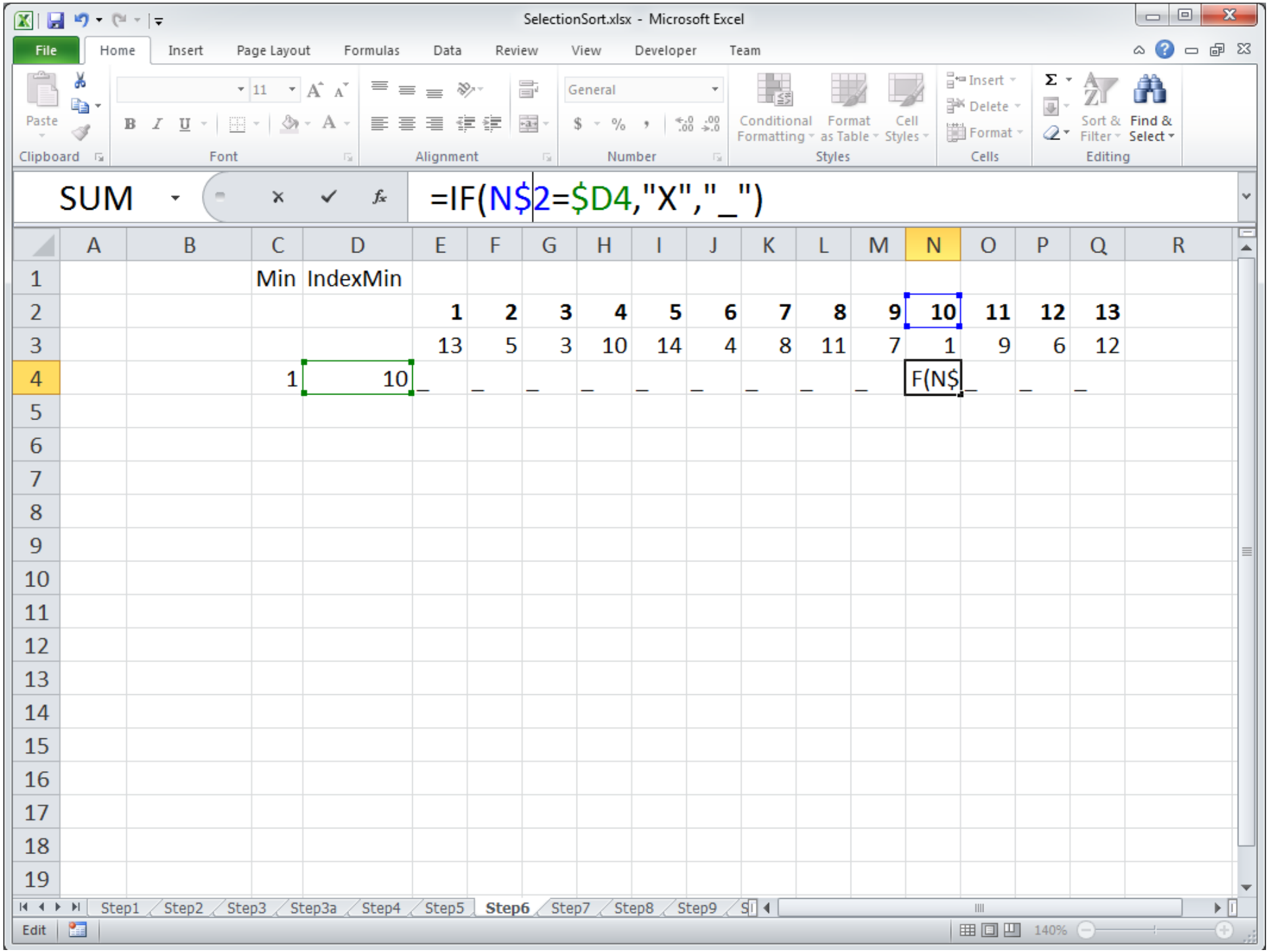
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SUM
=IF(N$2=$D4,"X","_")
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IndexMin
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10
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
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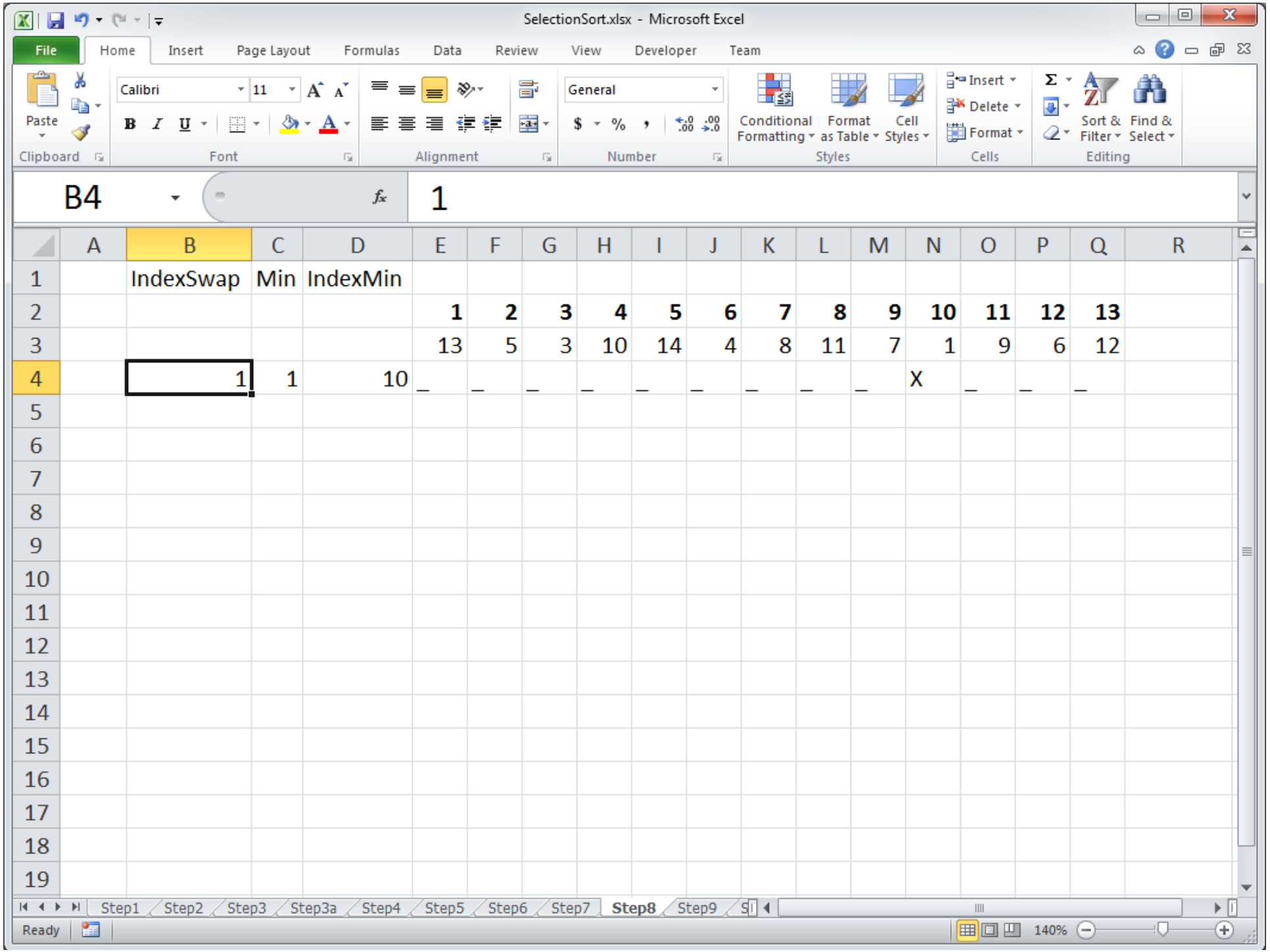
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Editing
B4
1
IndexSwap
Min
IndexMin
1 2 3 4 5 6 7 8 9 10 11 12 13
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1 1 10
X
Step1 Step2 Step3 Step3a Step4 Step5 Step6 Step7 Step8 Step9
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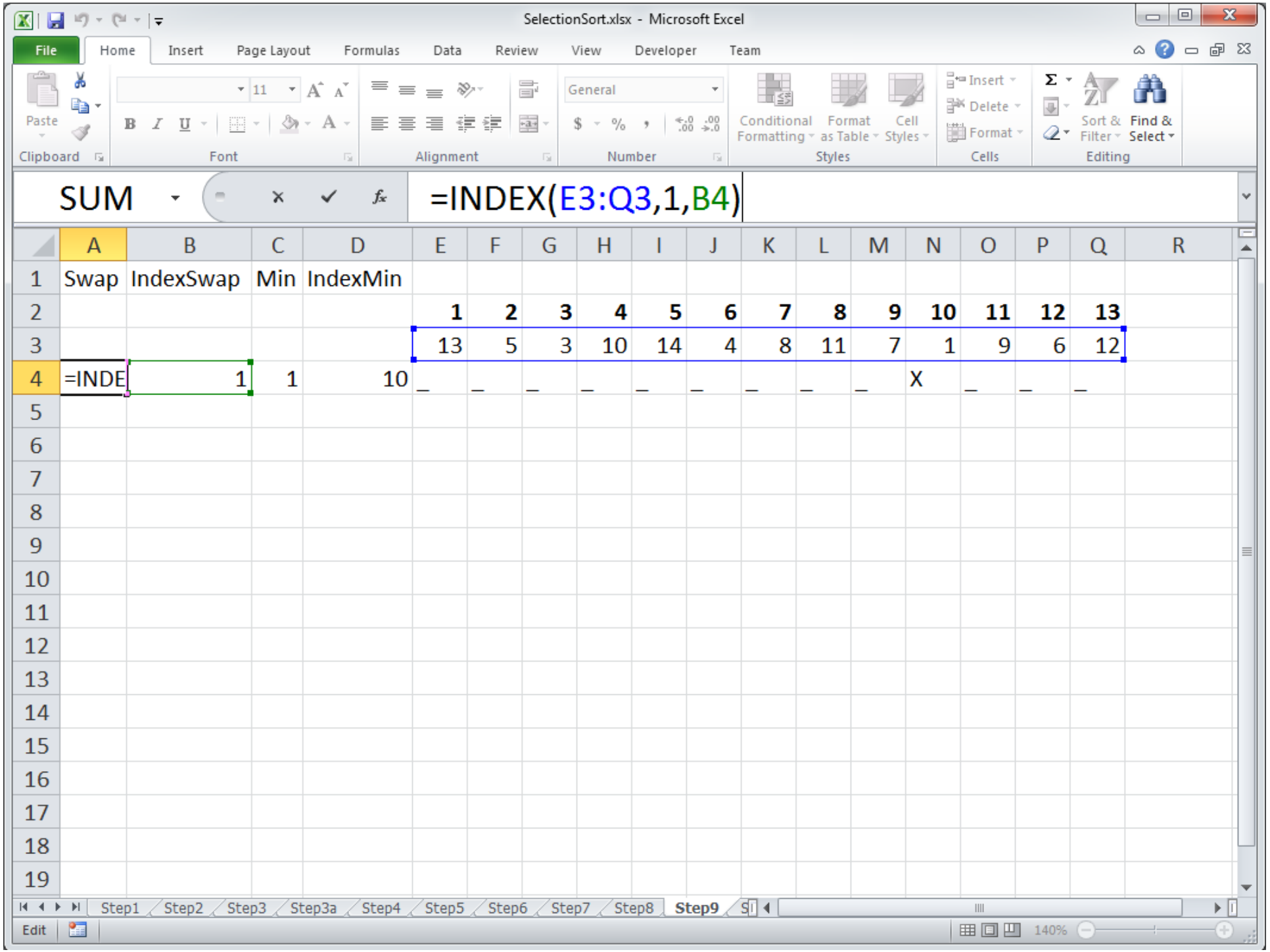
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SUM
=INDEX(E3:Q3,1,B4)
Swap
IndexSwap
Min
IndexMin
=INDE
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10
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
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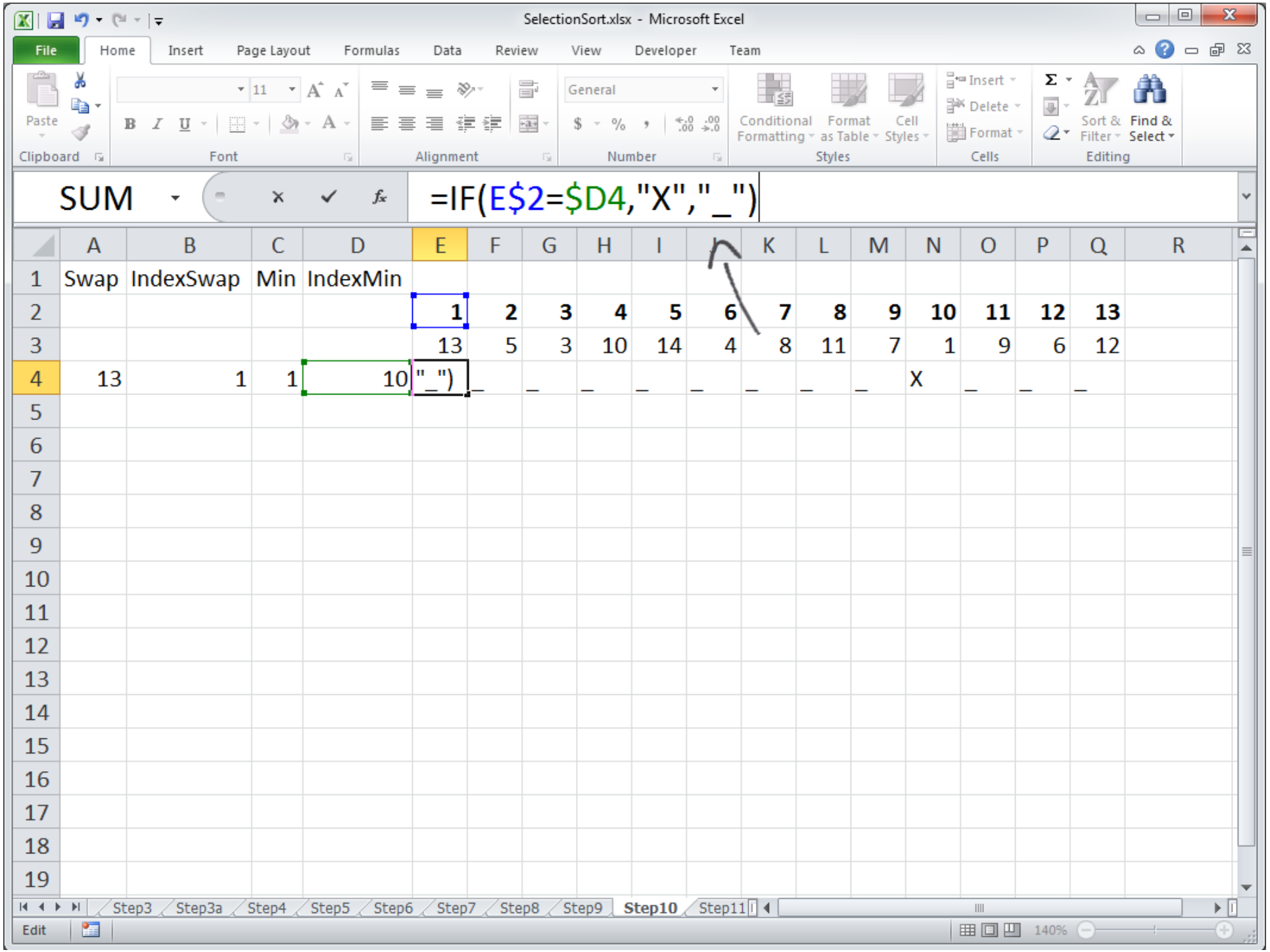
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13 5 3 10 14 4 8 11 7 1 9 6 12
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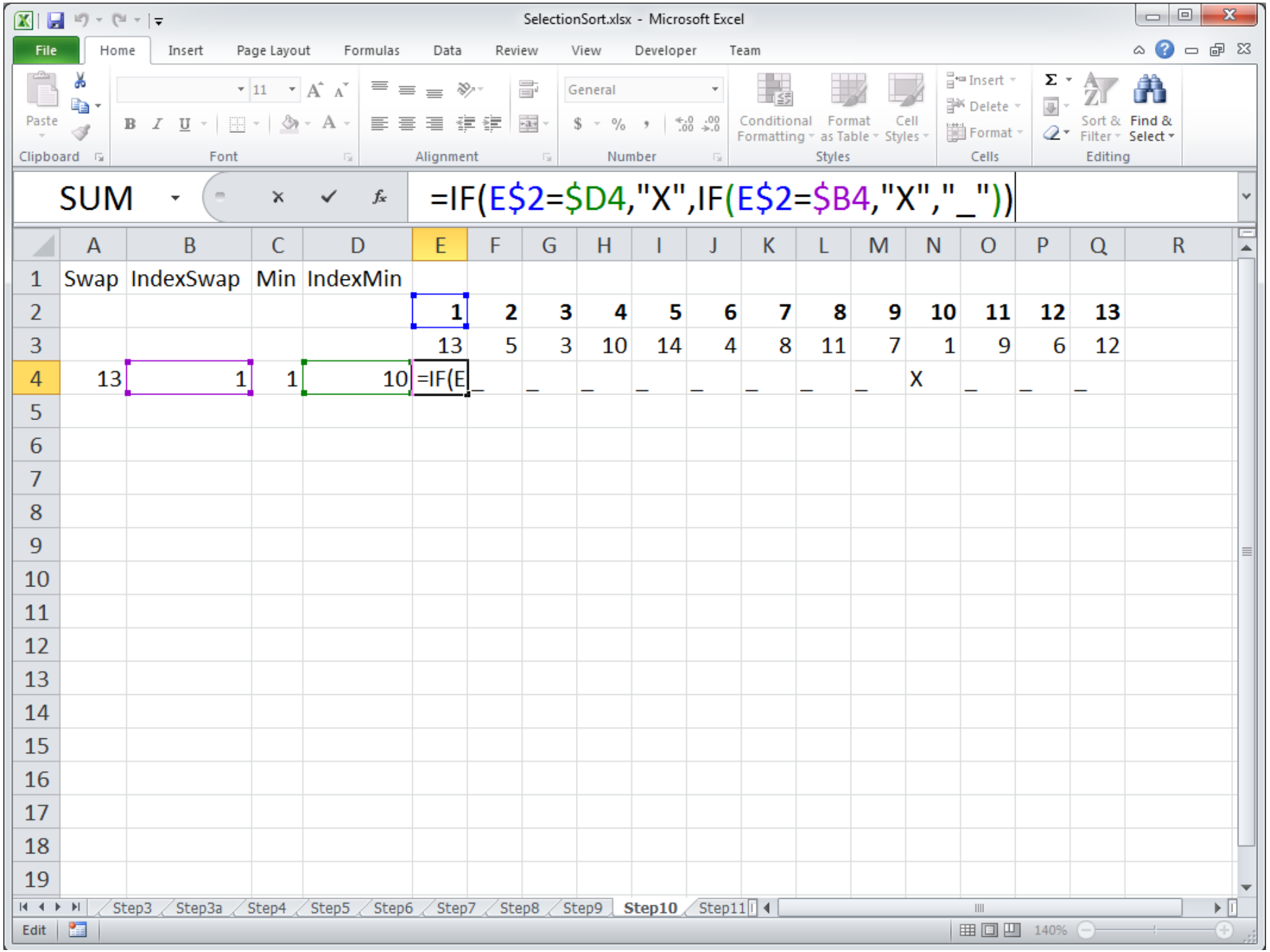
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SUM
=IF(E$2=$D4,"X",IF(E$2=$B4,"X","_"))
Swap
IndexSwap
Min
IndexMin
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
13
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=IF(E
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Step3
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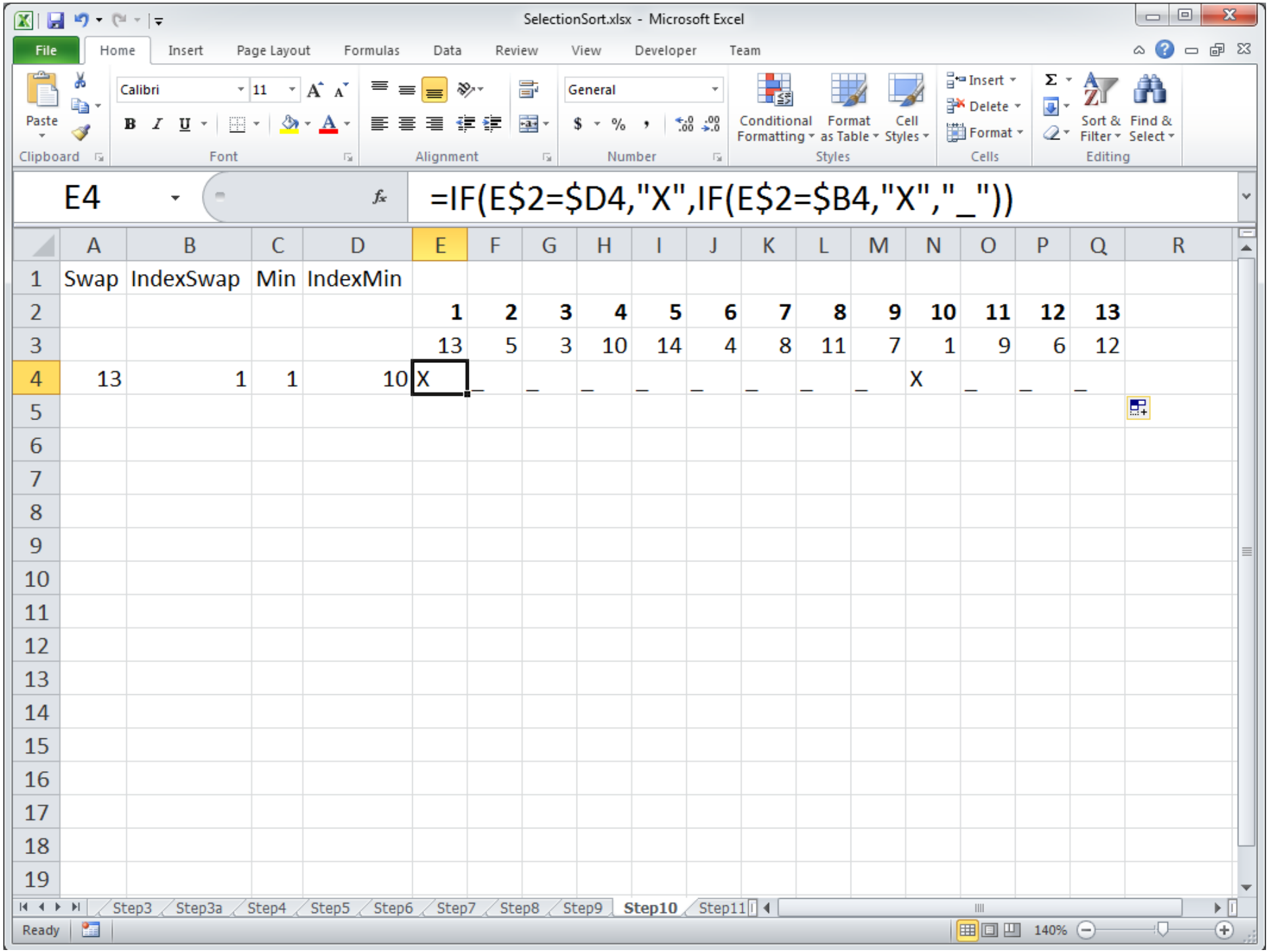

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13	1	1	10	X	_	_	_	_	_	_	_	_	X	_	_	_	
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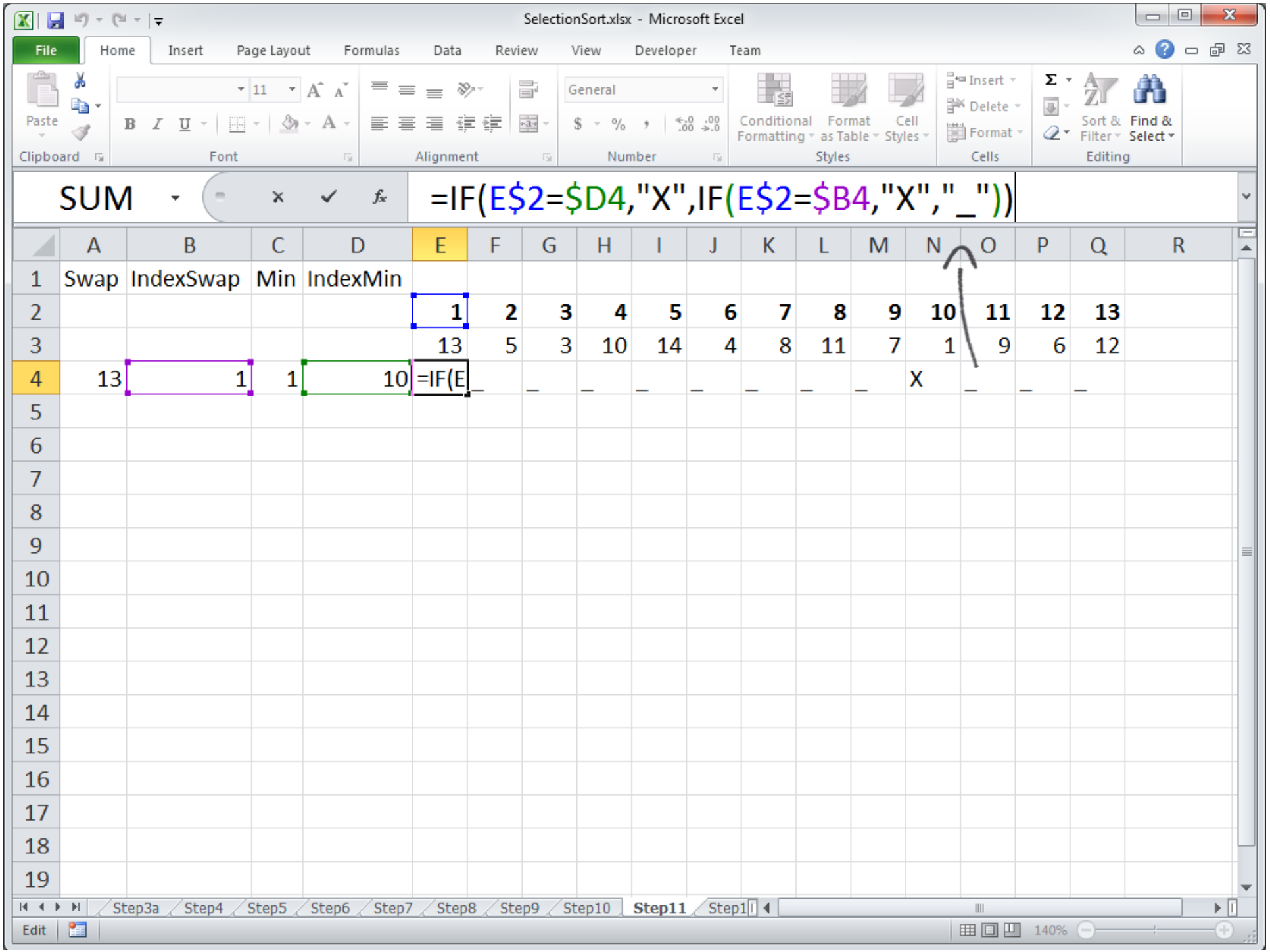
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SUM
=IF(E$2=$D4,"X",IF(E$2=$B4,"X","_"))
Swap
IndexSwap
Min
IndexMin
13
1
1
10
=IF(E
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 10 14 4 8 11 7 1 9 6 12
X
Step3a
Step4
Step5
Step6
Step7
Step8
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Step10
Step11
Step1
Edit
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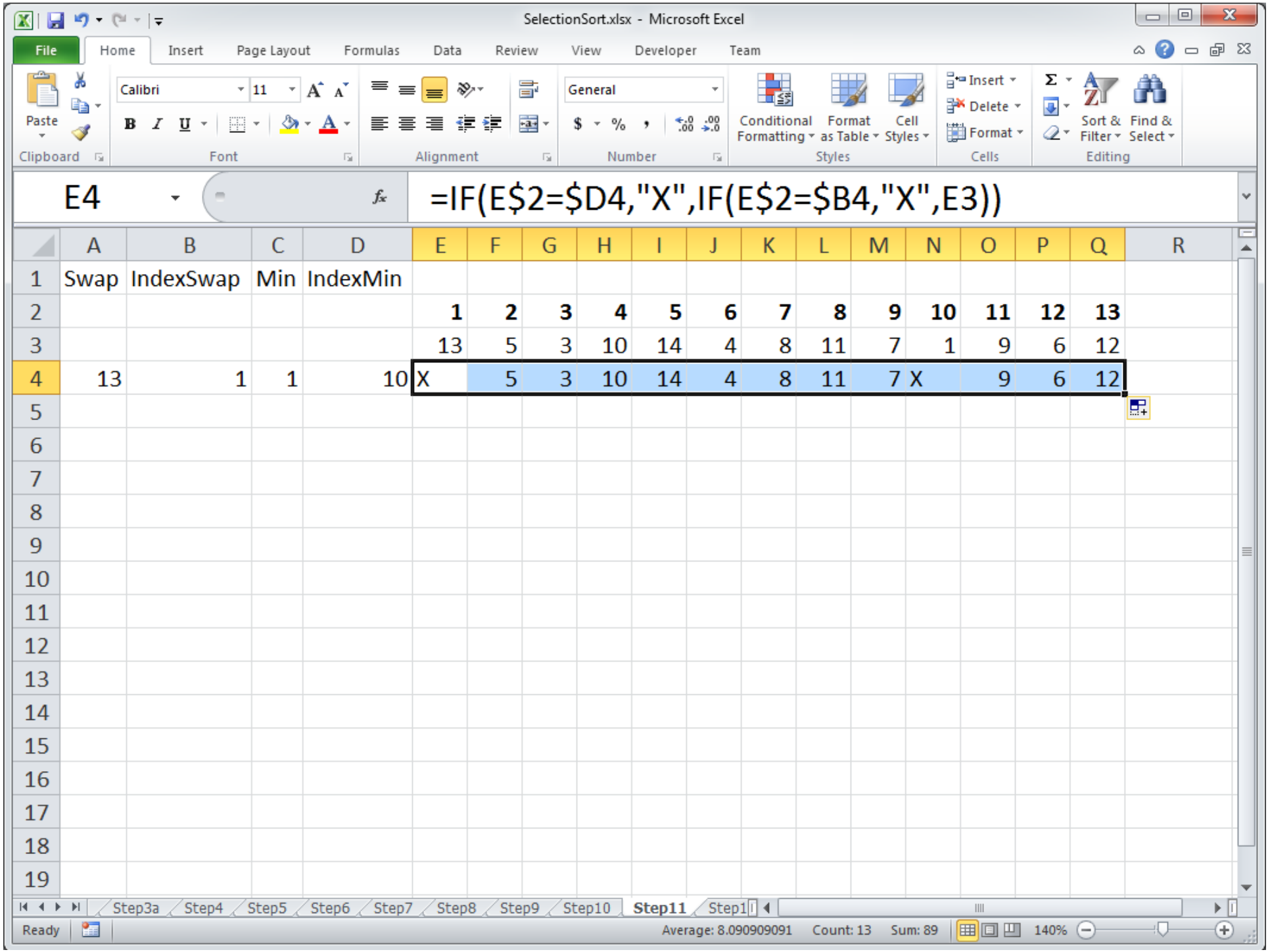

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Swap	IndexSwap	Min	IndexMin														
2					**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13	1	1	10	X	5	3	10	14	4	8	11	7	X	9	6	12	
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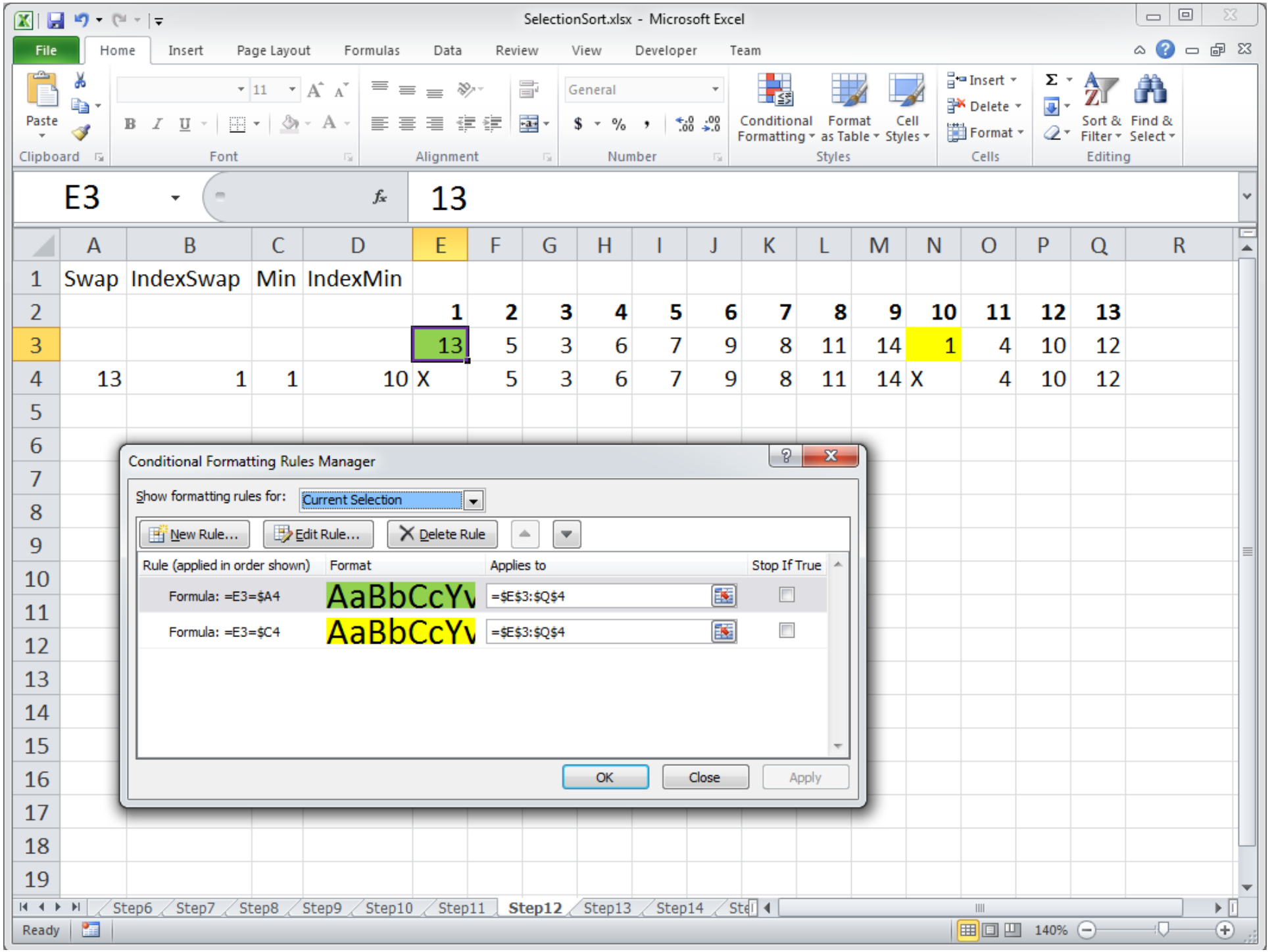
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Find & Select
Editing
E3
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Swap
IndexSwap
Min
IndexMin
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1
1
10
Conditional Formatting Rules Manager
Show formatting rules for:
Current Selection
New Rule...
Edit Rule...
Delete Rule
Rule (applied in order shown)
Format
Applies to
Stop If True
Formula: =E3=$A4
Formula: =E3=$C4
=$E$3:$Q$4
OK
Close
Apply
Step6
Step7
Step8
Step9
Step10
Step11
Step12
Step13
Step14
Ready
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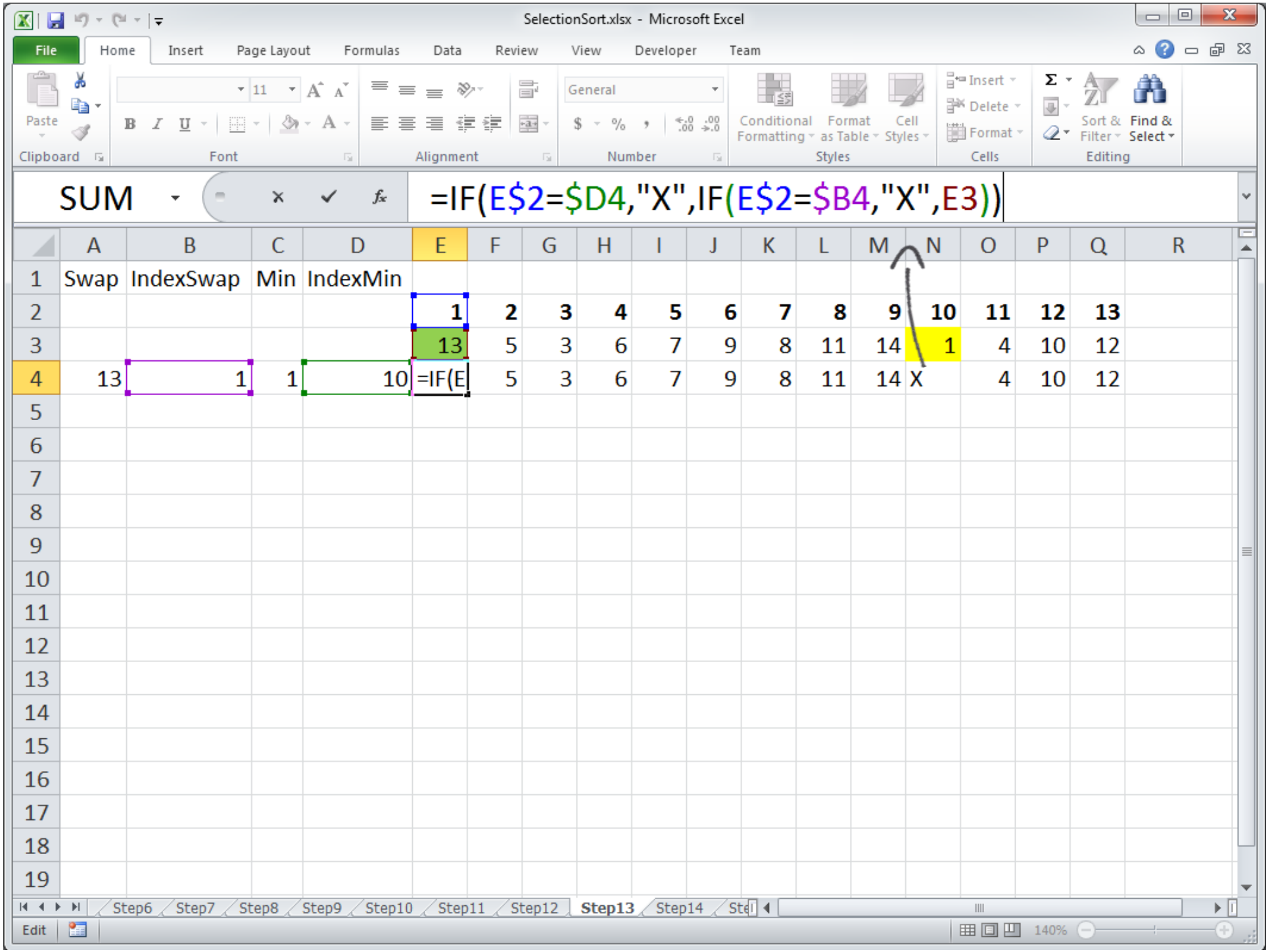
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SUM
=IF(E$2=$D4,"X",IF(E$2=$B4,"X",E3))
Swap
IndexSwap
Min
IndexMin
13
1
1
10
=IF(E
1 2 3 4 5 6 7 8 9 10 11 12 13
13 5 3 6 7 9 8 11 14 1 4 10 12
13 5 3 6 7 9 8 11 14 X 4 10 12
Step6 Step7 Step8 Step9 Step10 Step11 Step12 Step13 Step14
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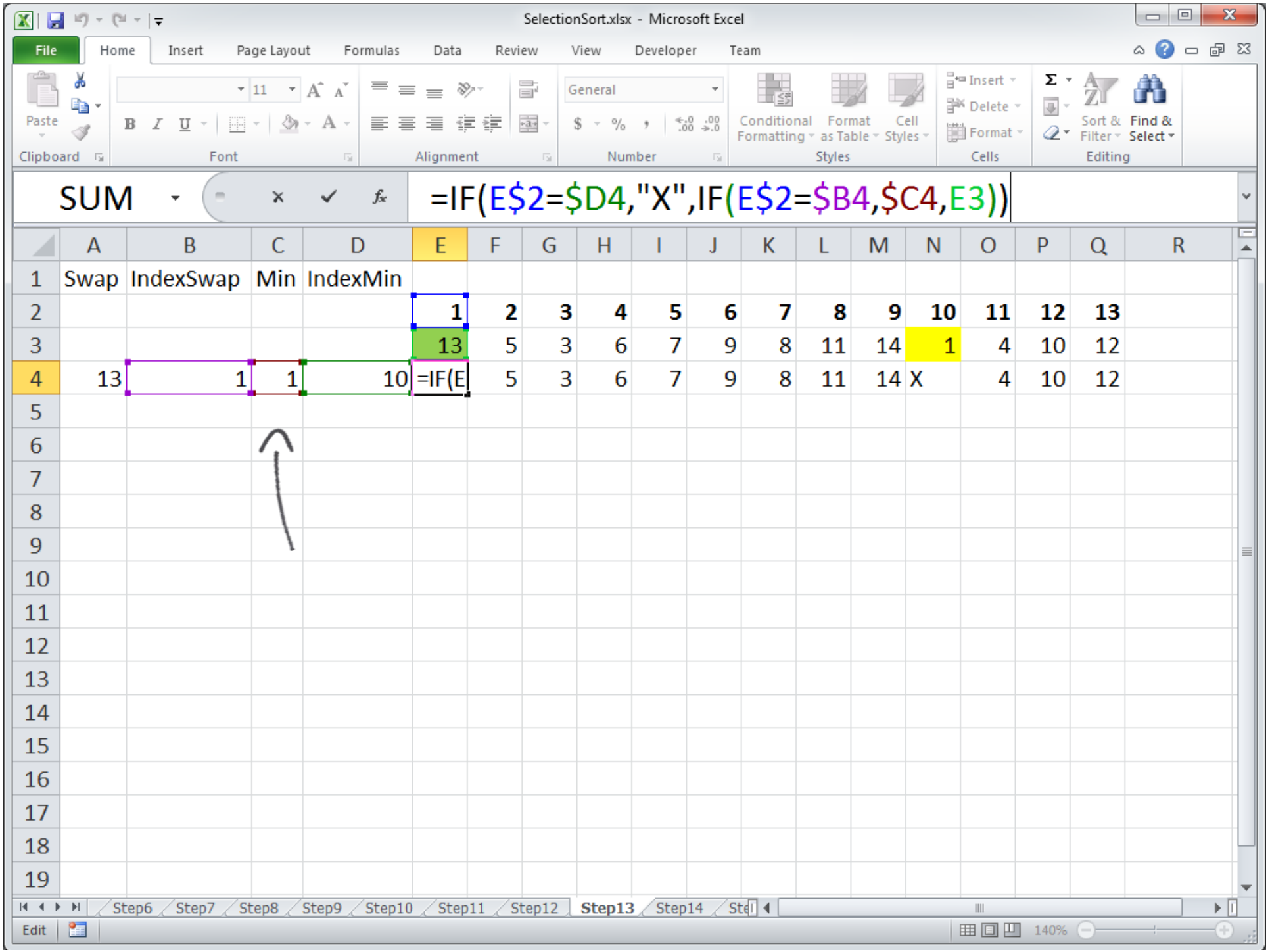
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Find & Select
Editing
SUM
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A B C D E F G H I J K L M N O P Q R
1 Swap IndexSwap Min IndexMin
2 1 2 3 4 5 6 7 8 9 10 11 12 13
3 13 5 3 6 7 9 8 11 14 1 4 10 12
4 13 1 1 10 =IF(E 5 3 6 7 9 8 11 14 X 4 10 12
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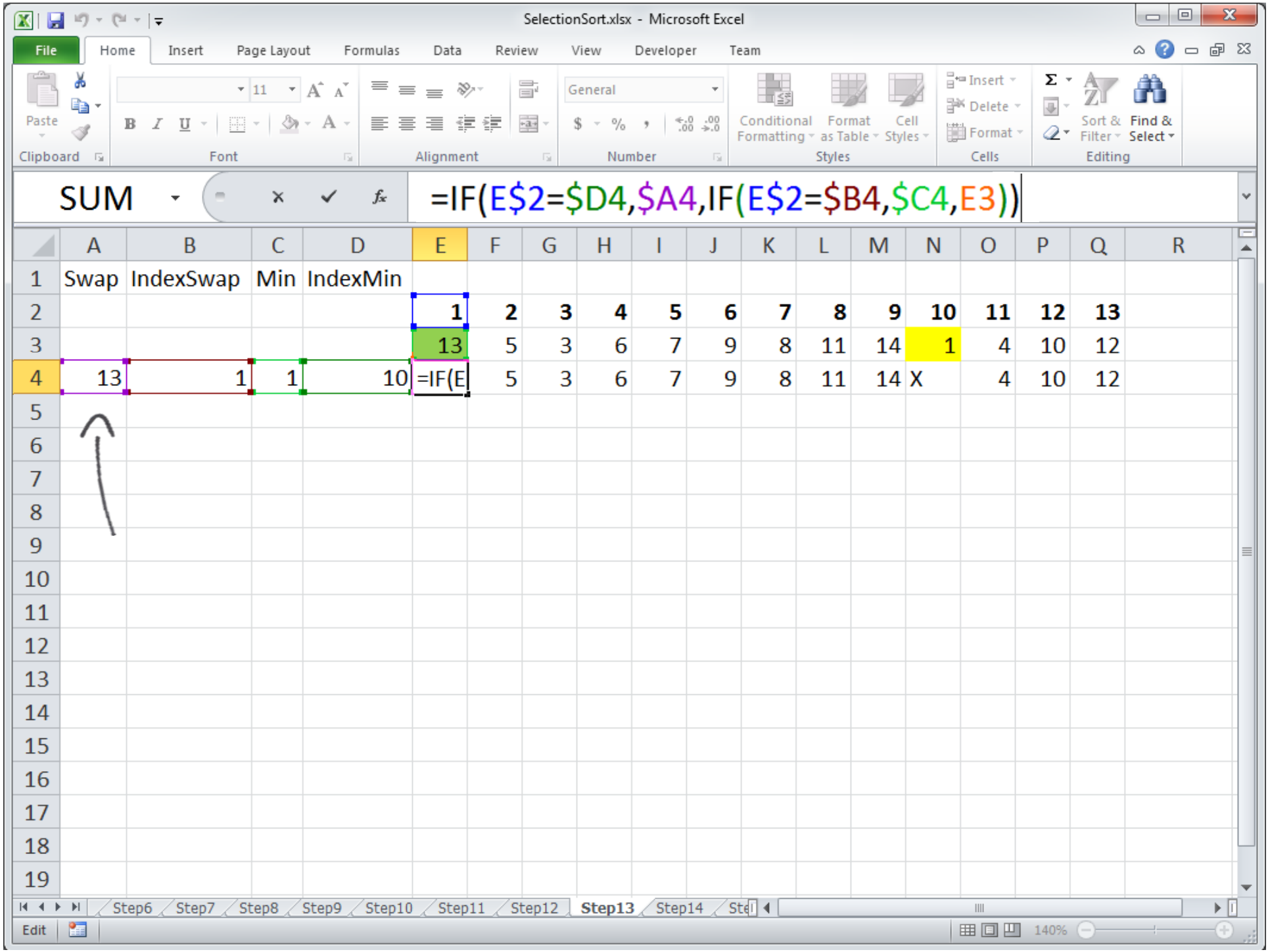
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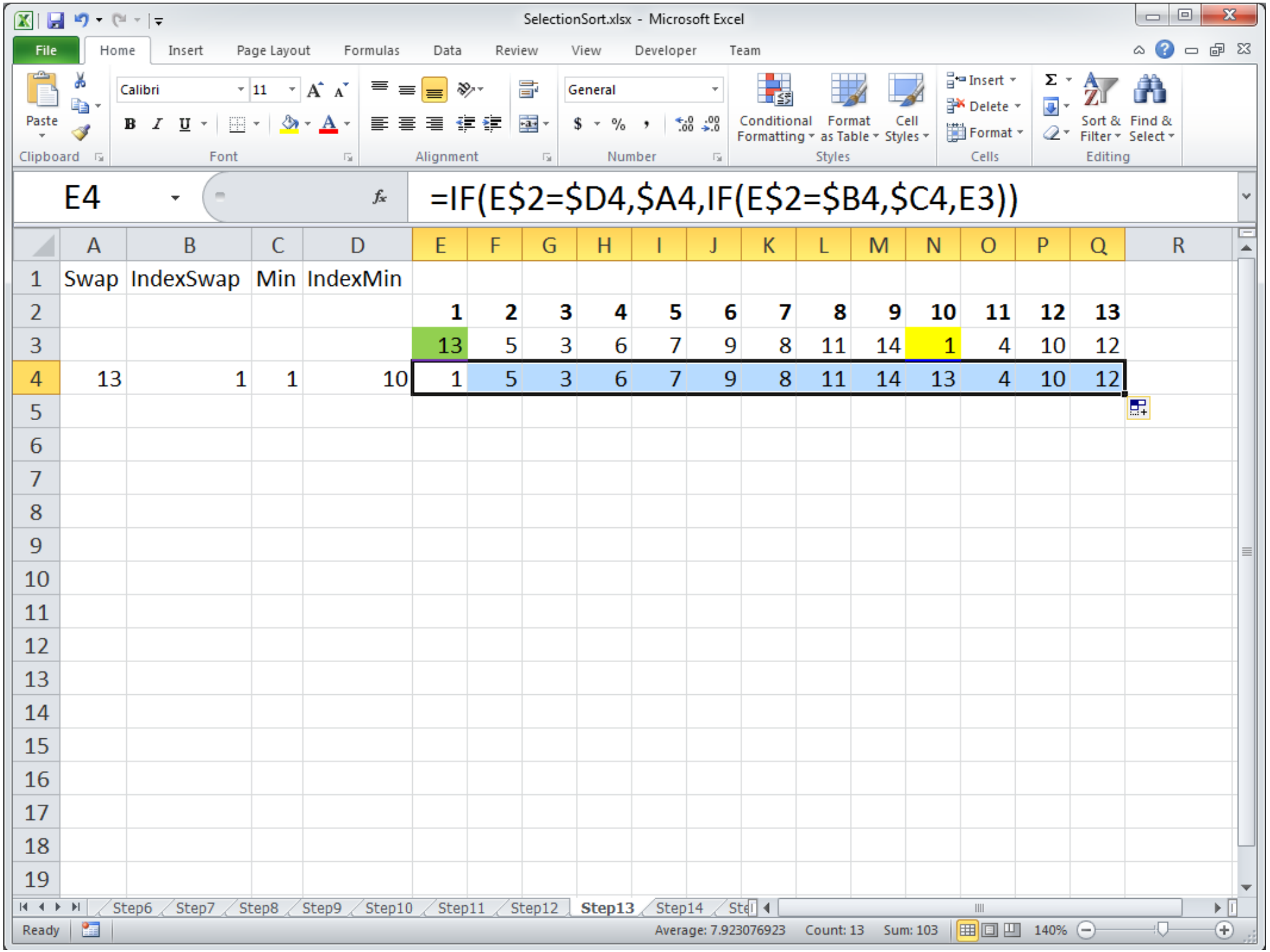

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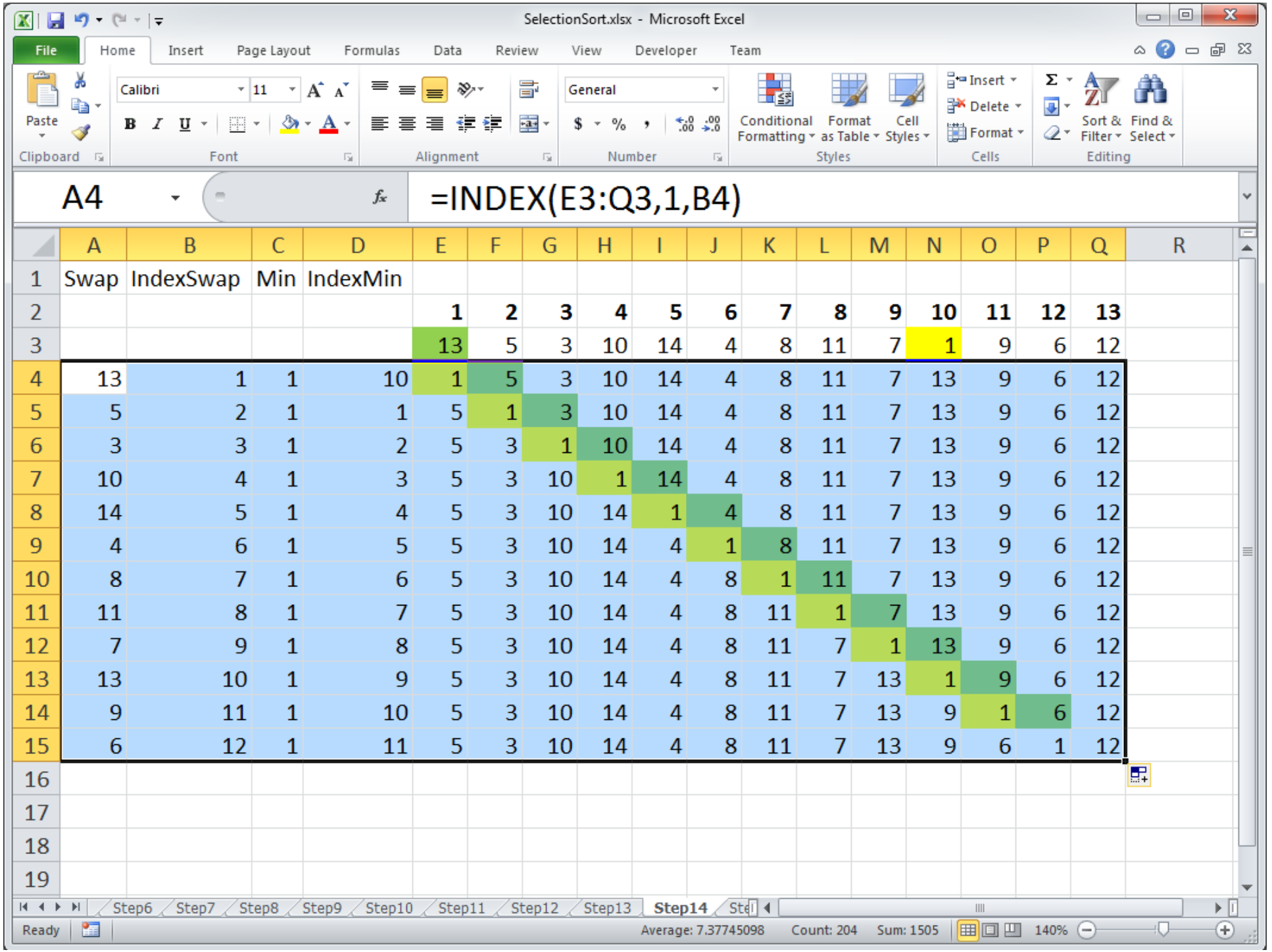

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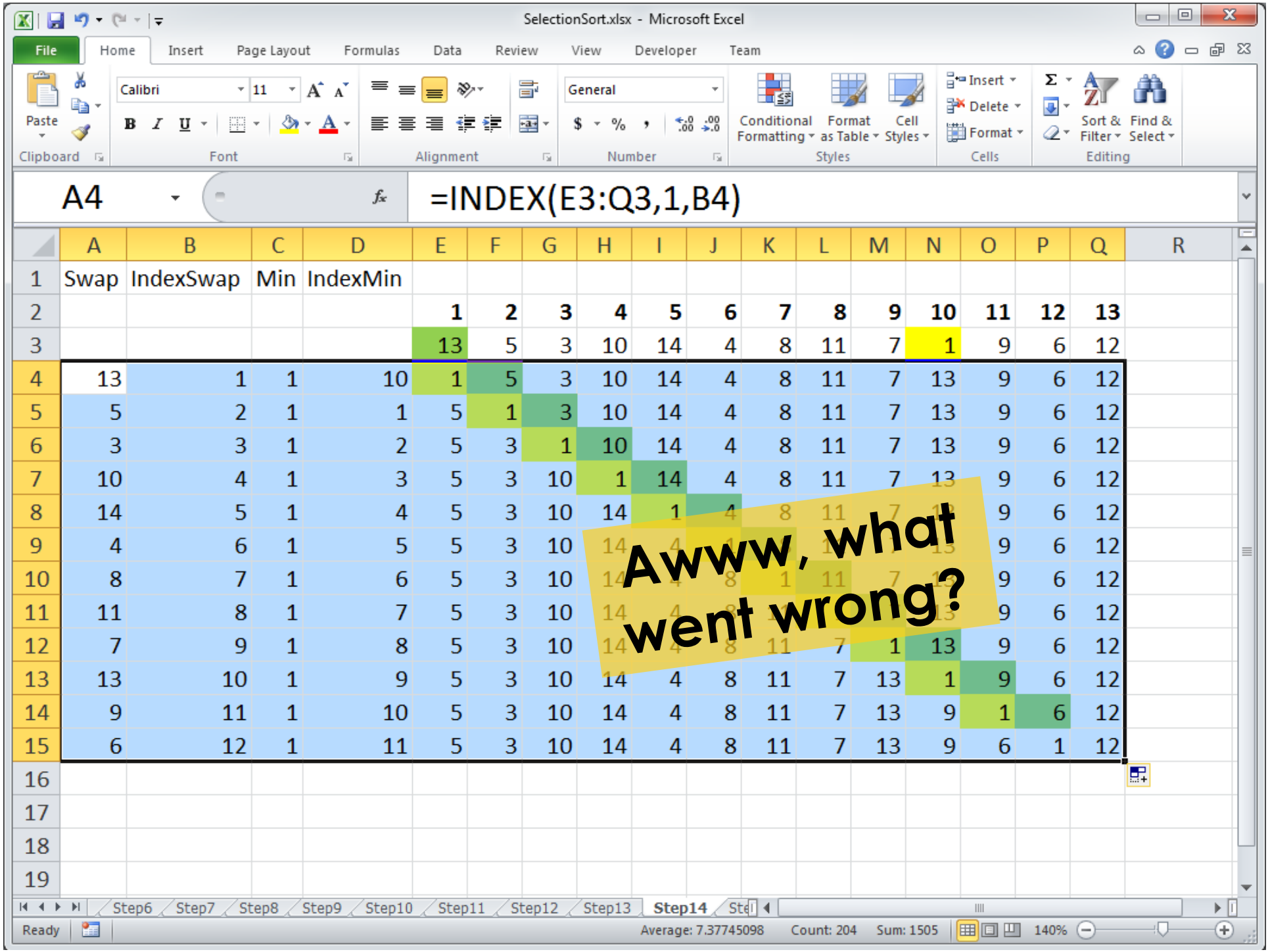
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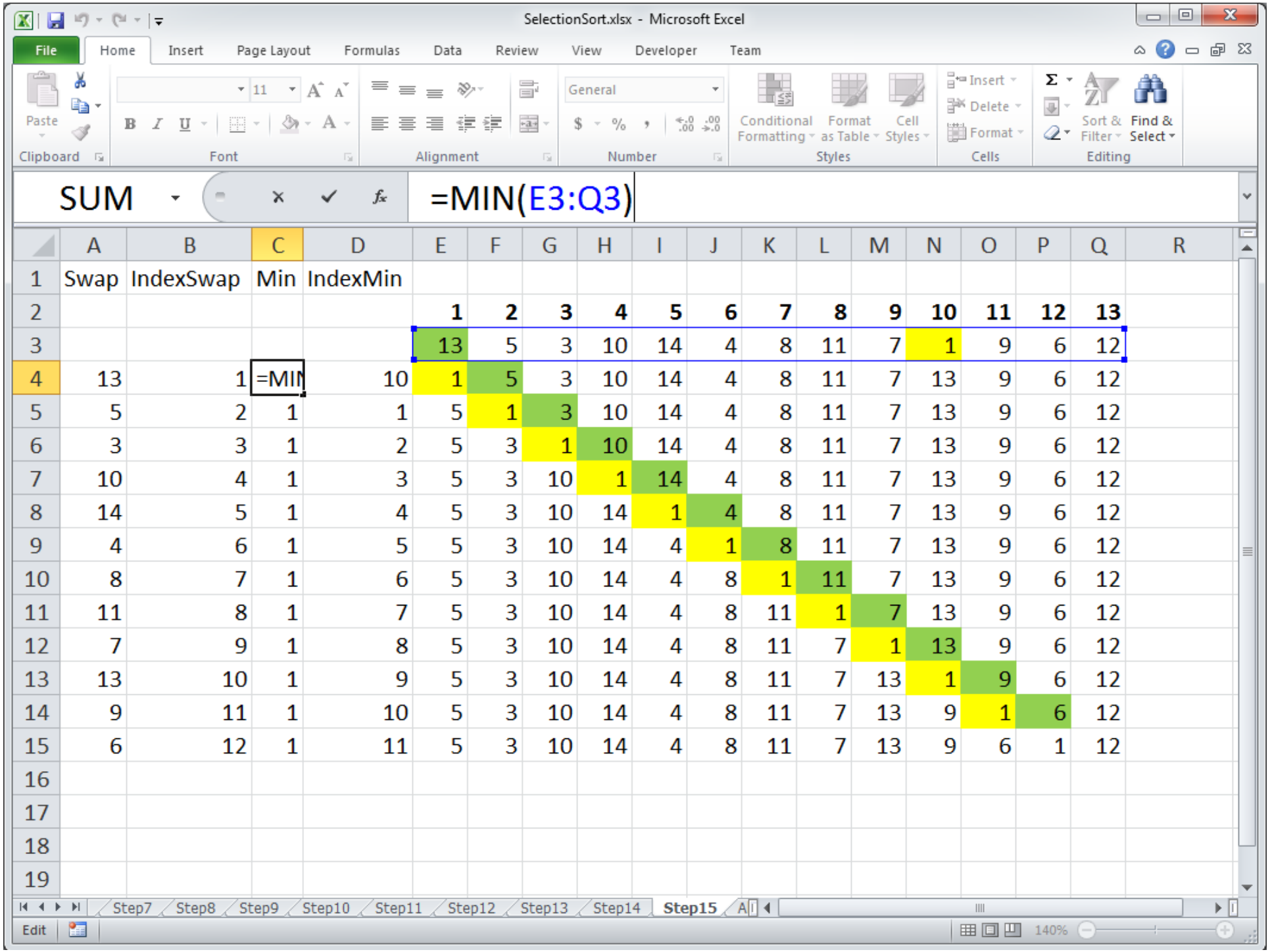

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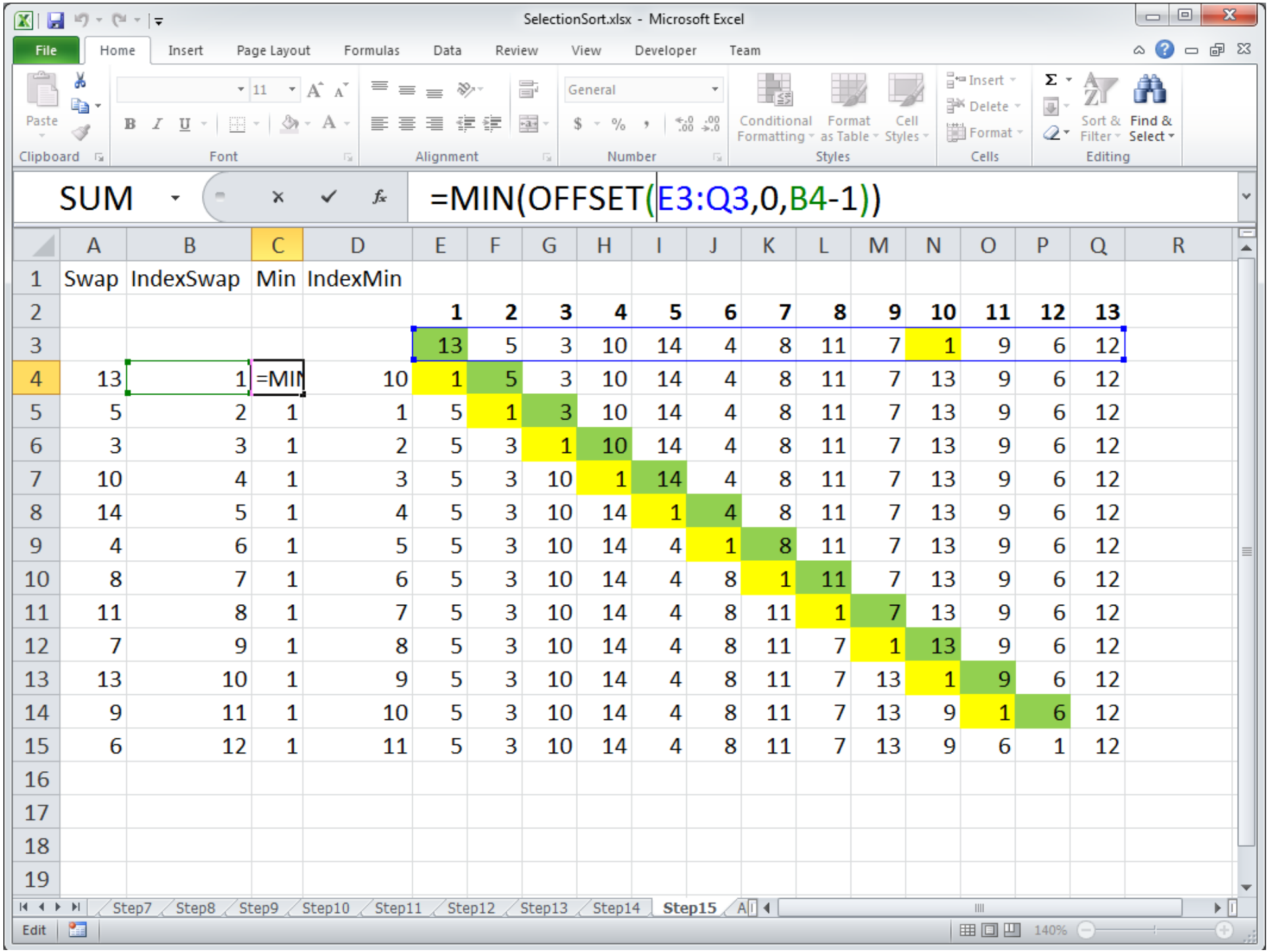

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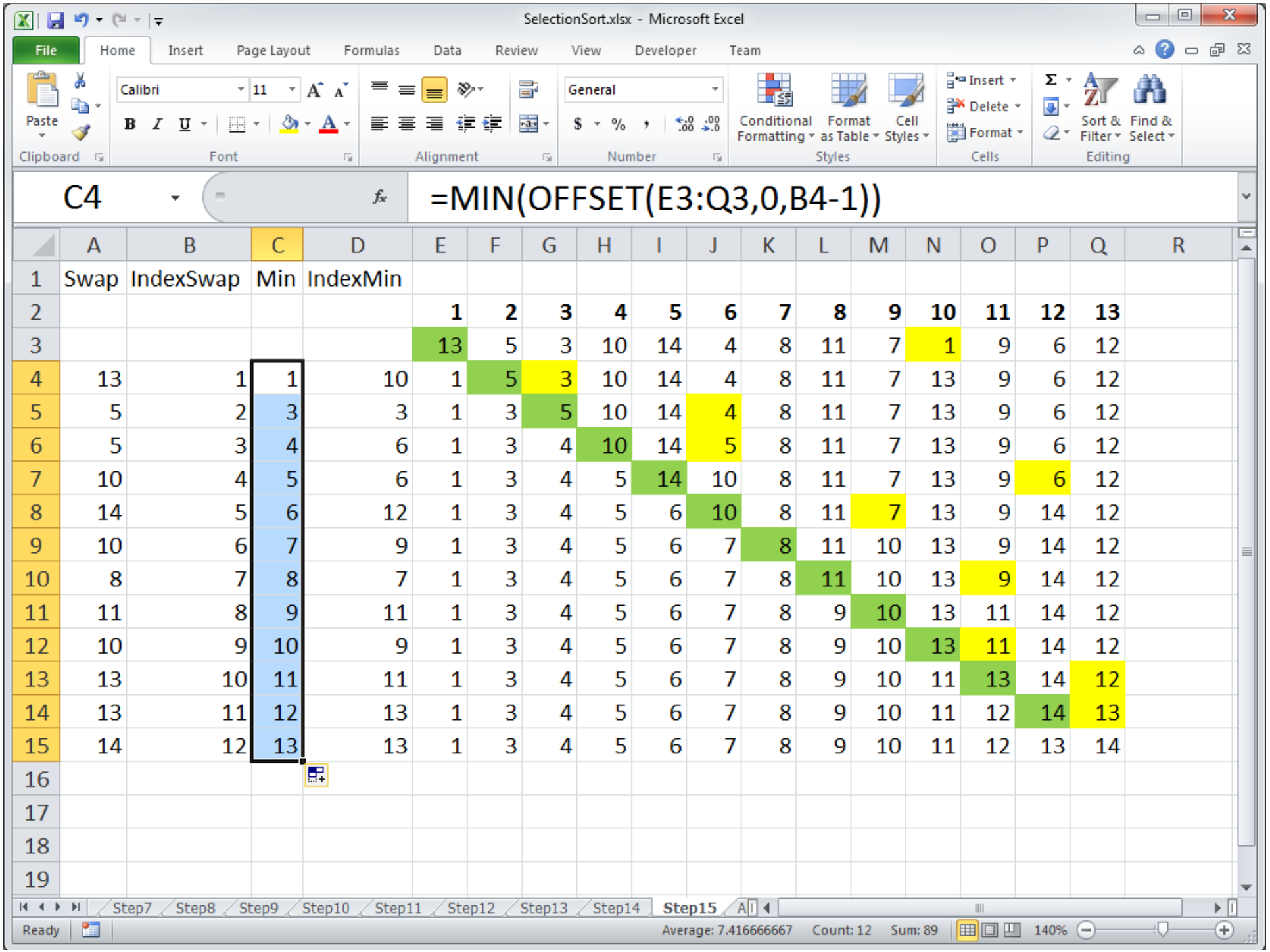

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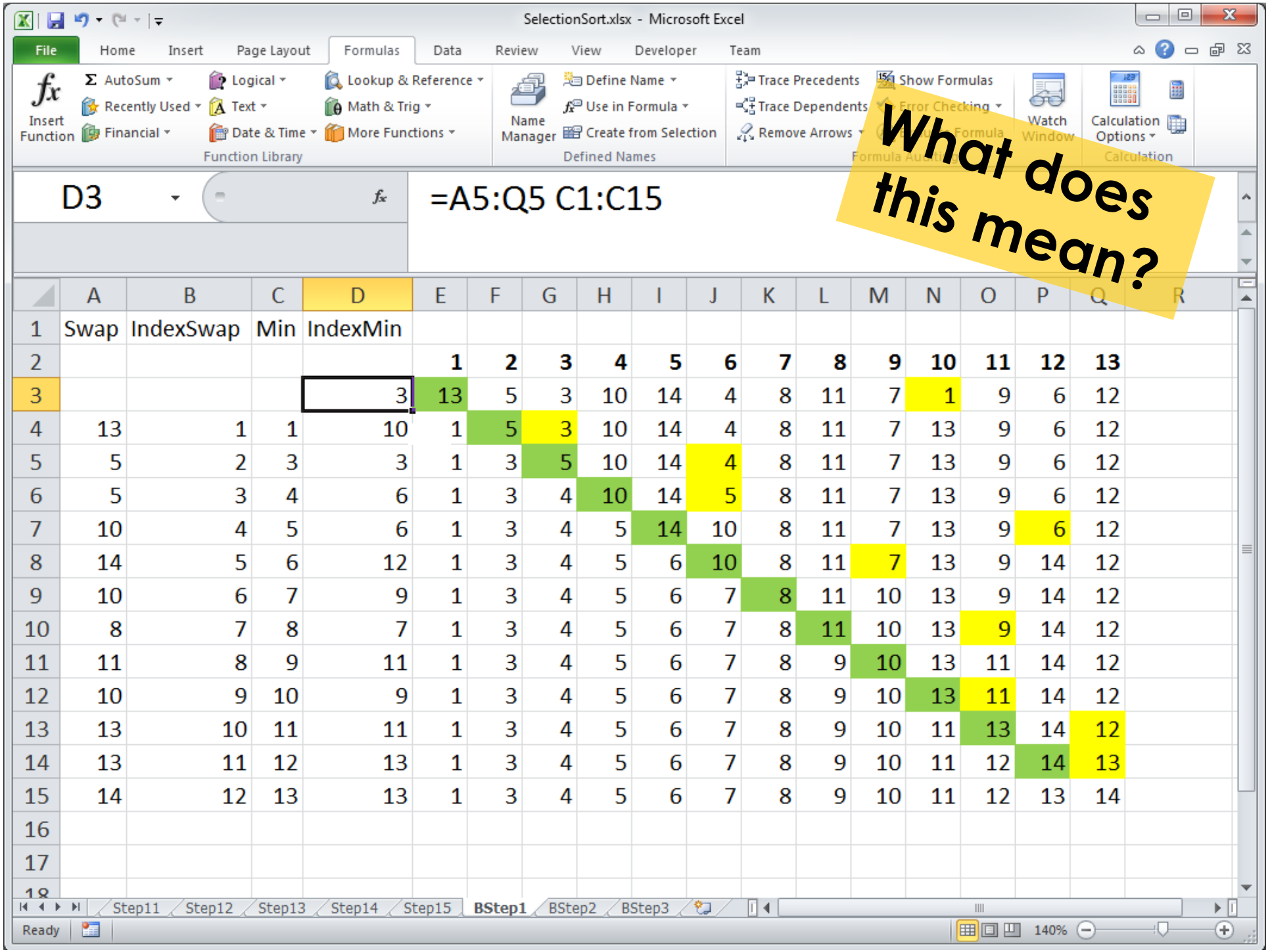
Level 2: a bit scarier



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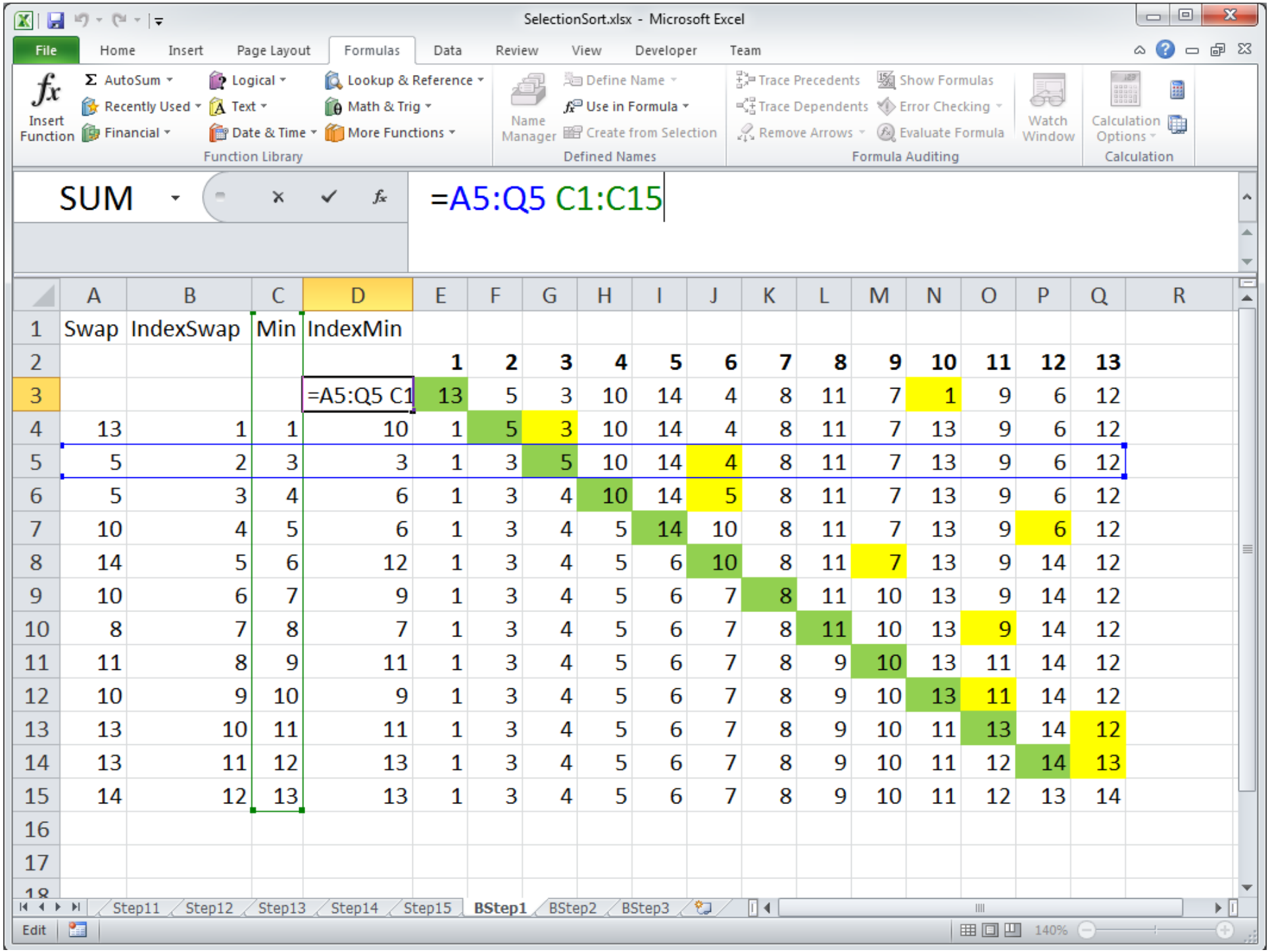

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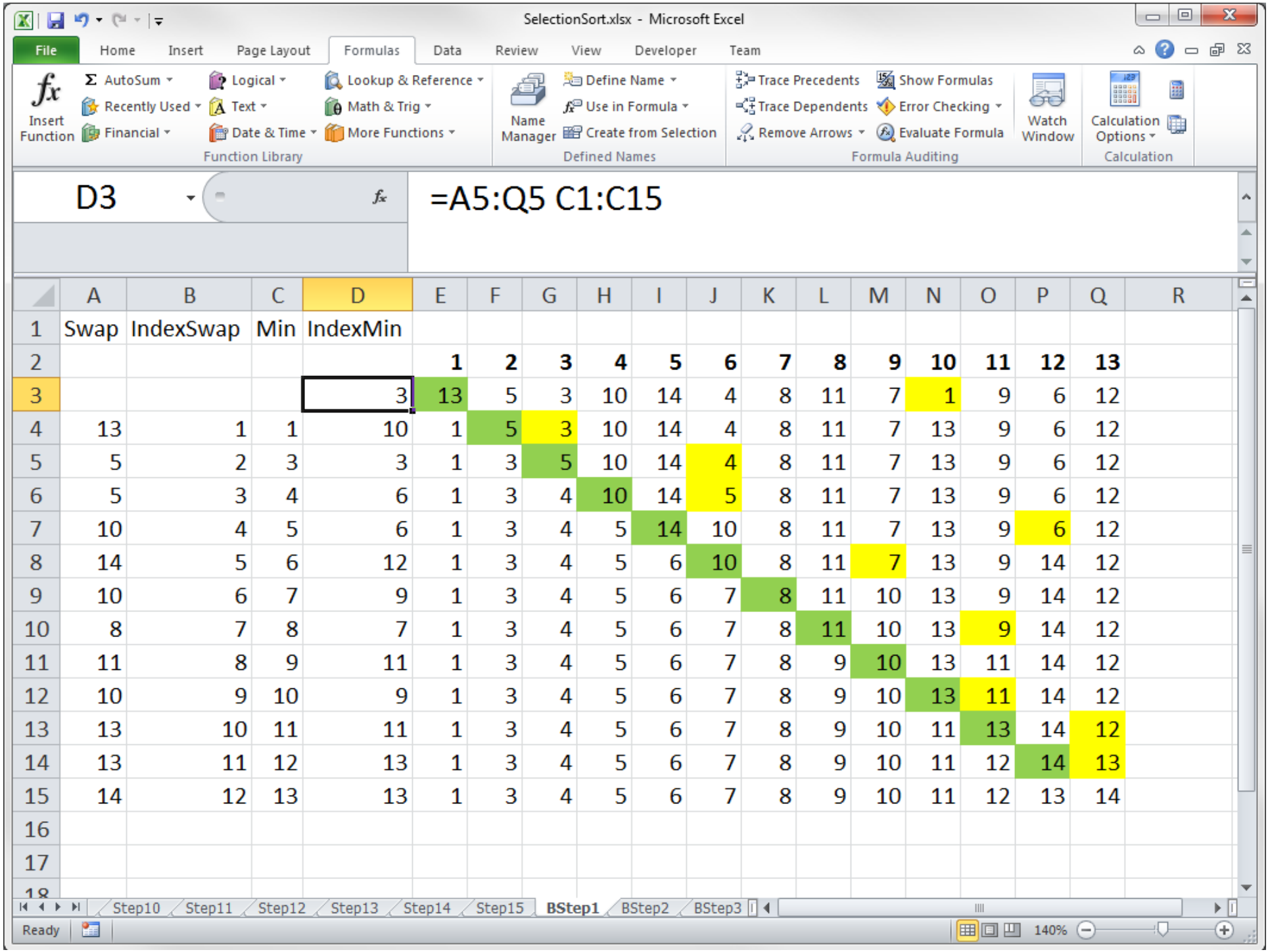

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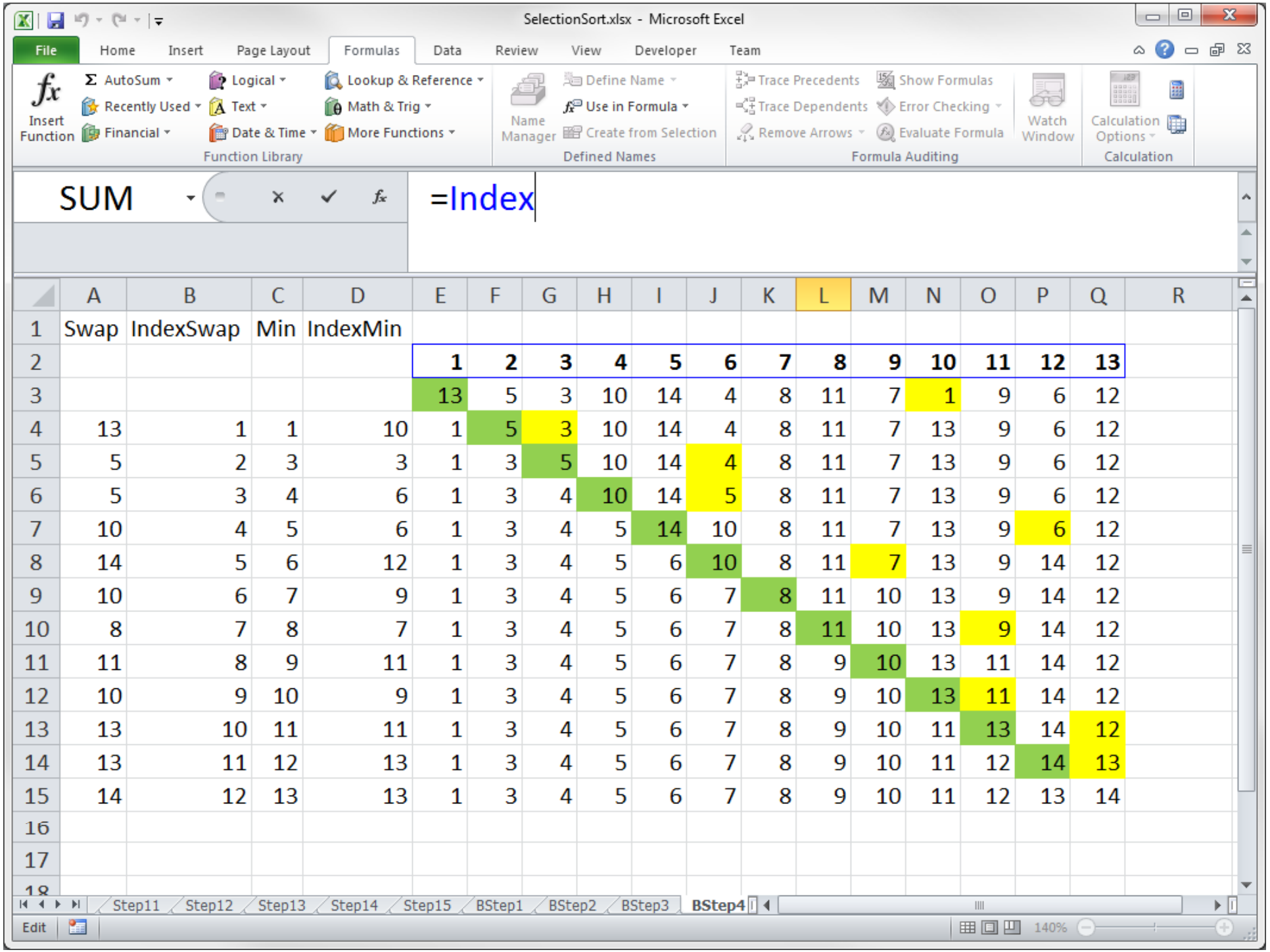

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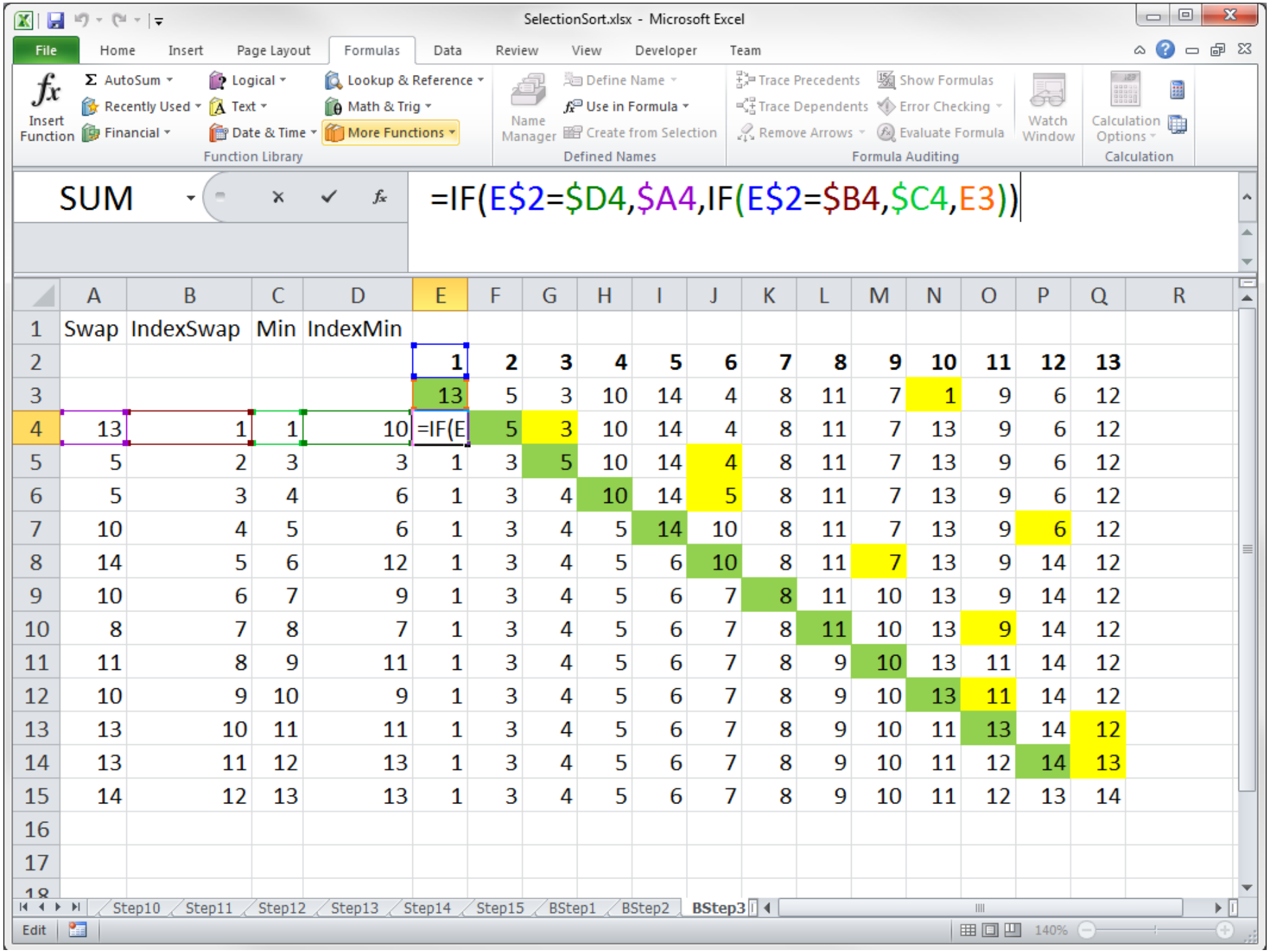

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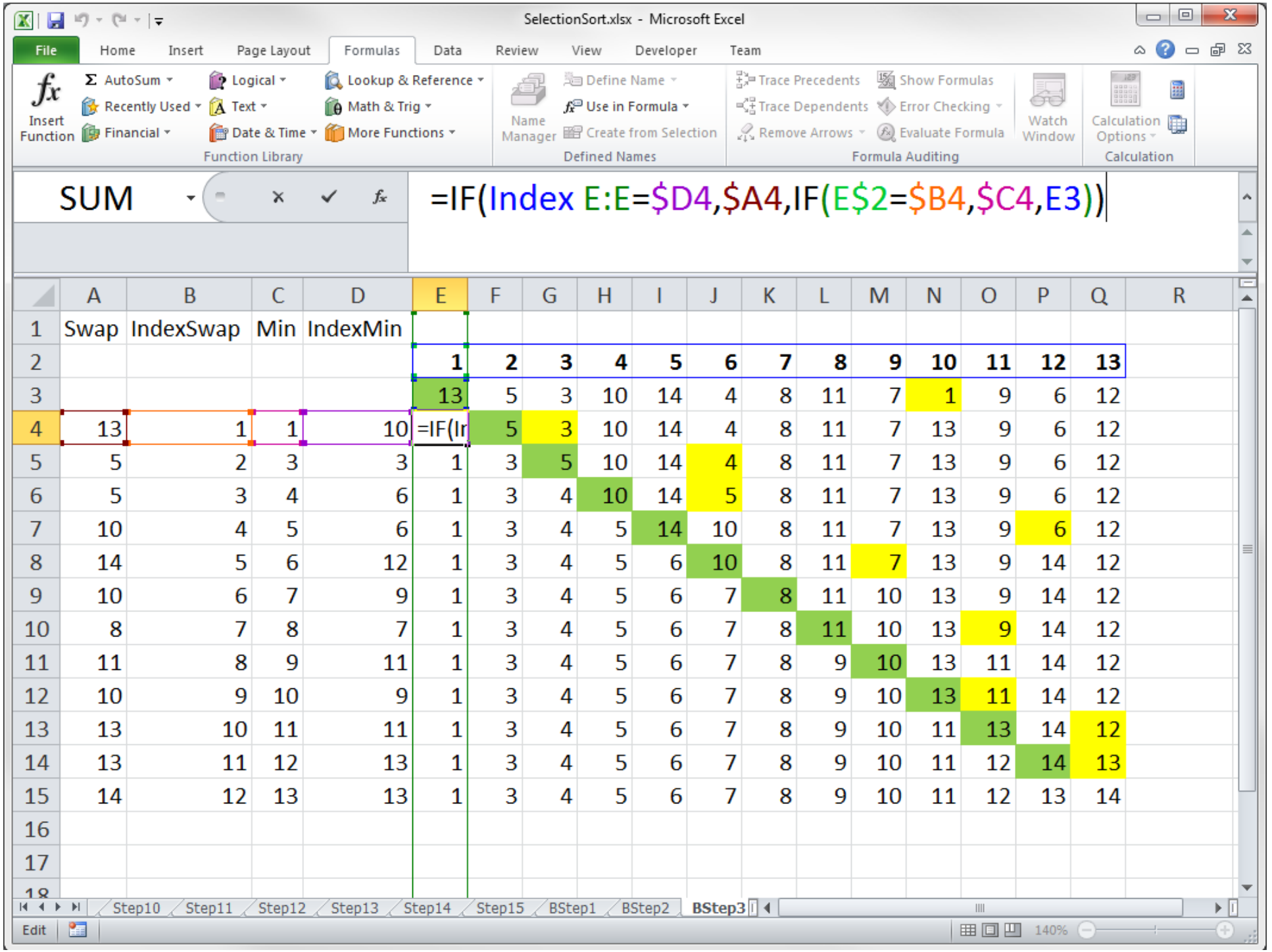

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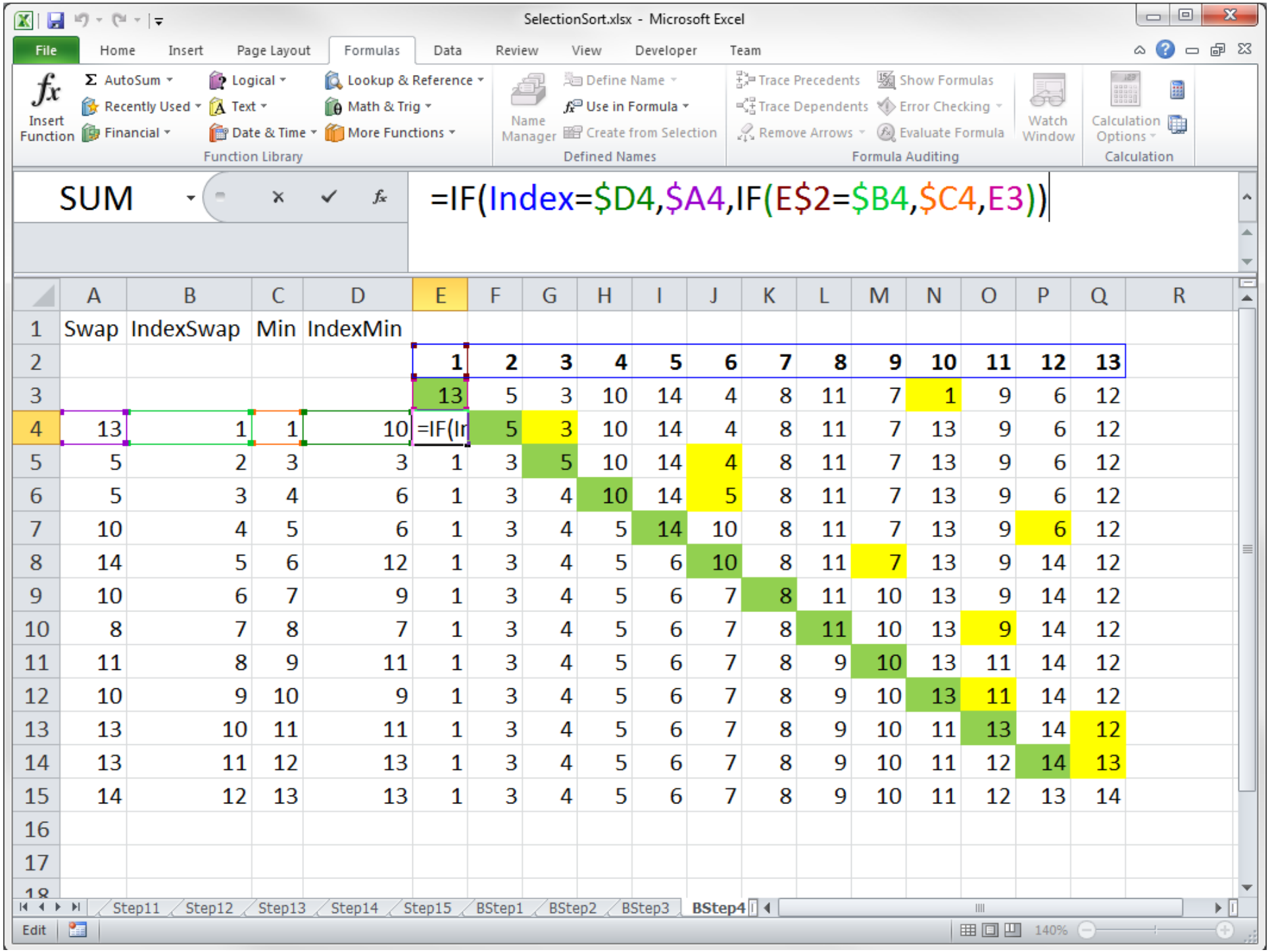

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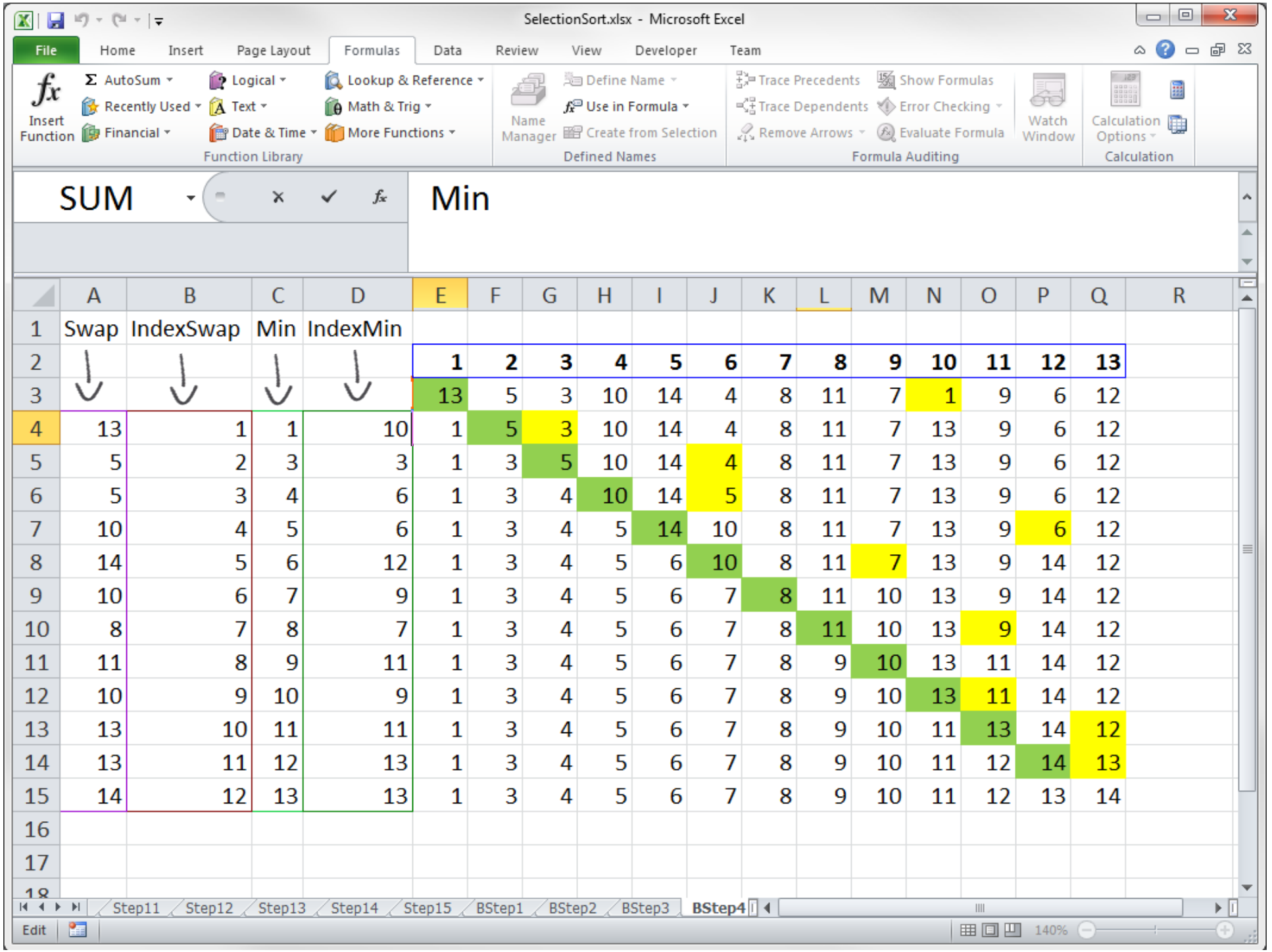

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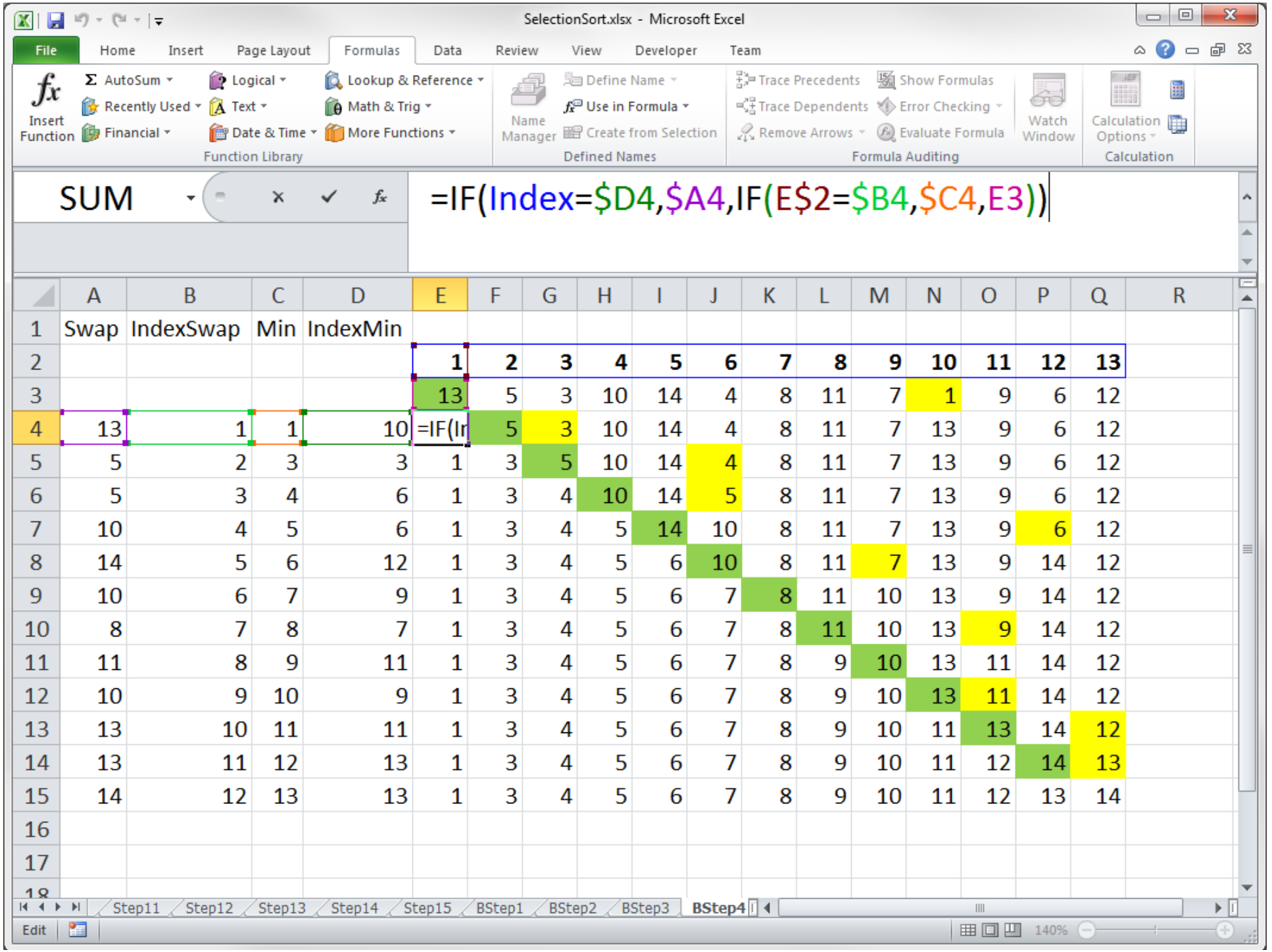

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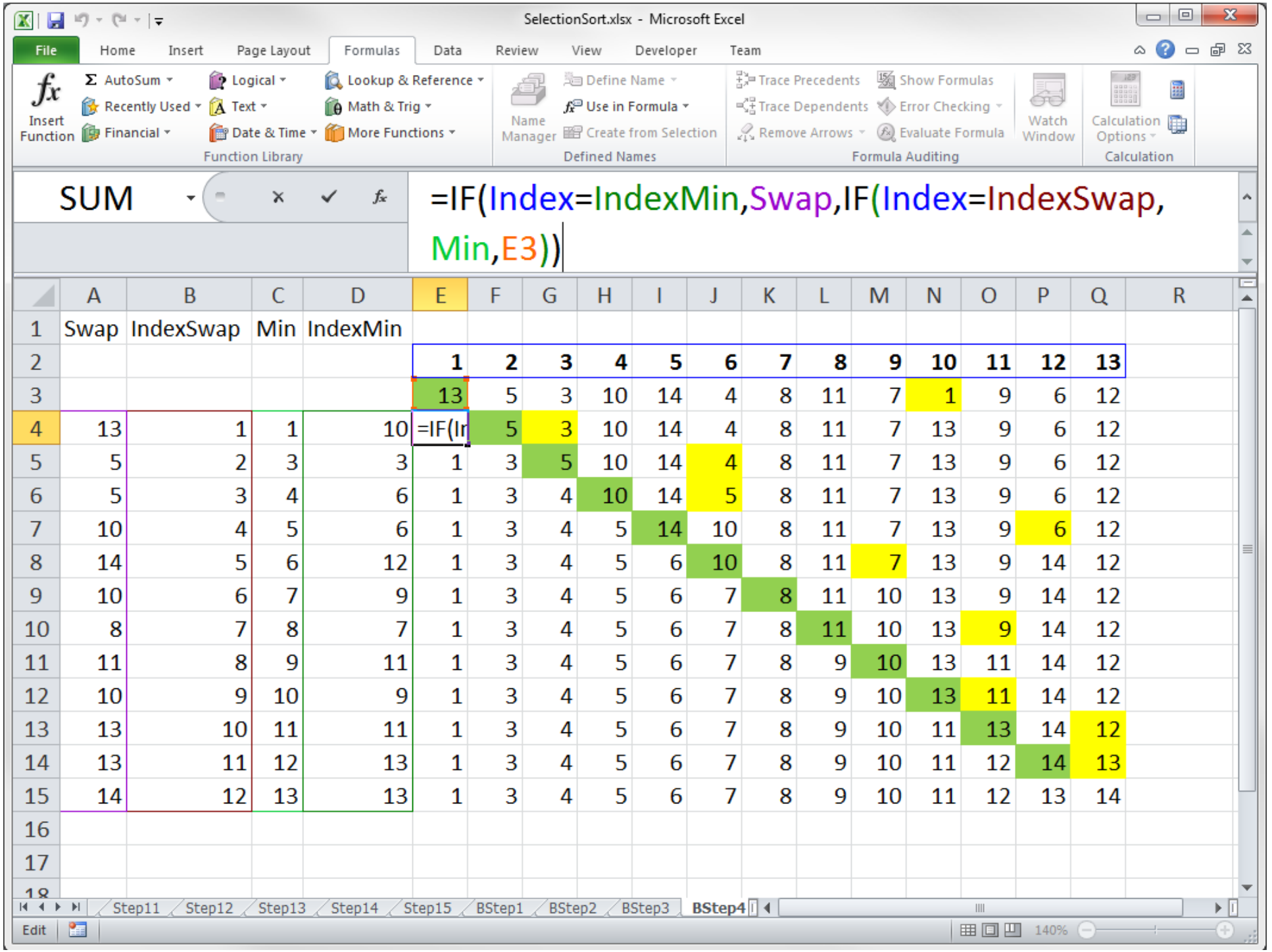

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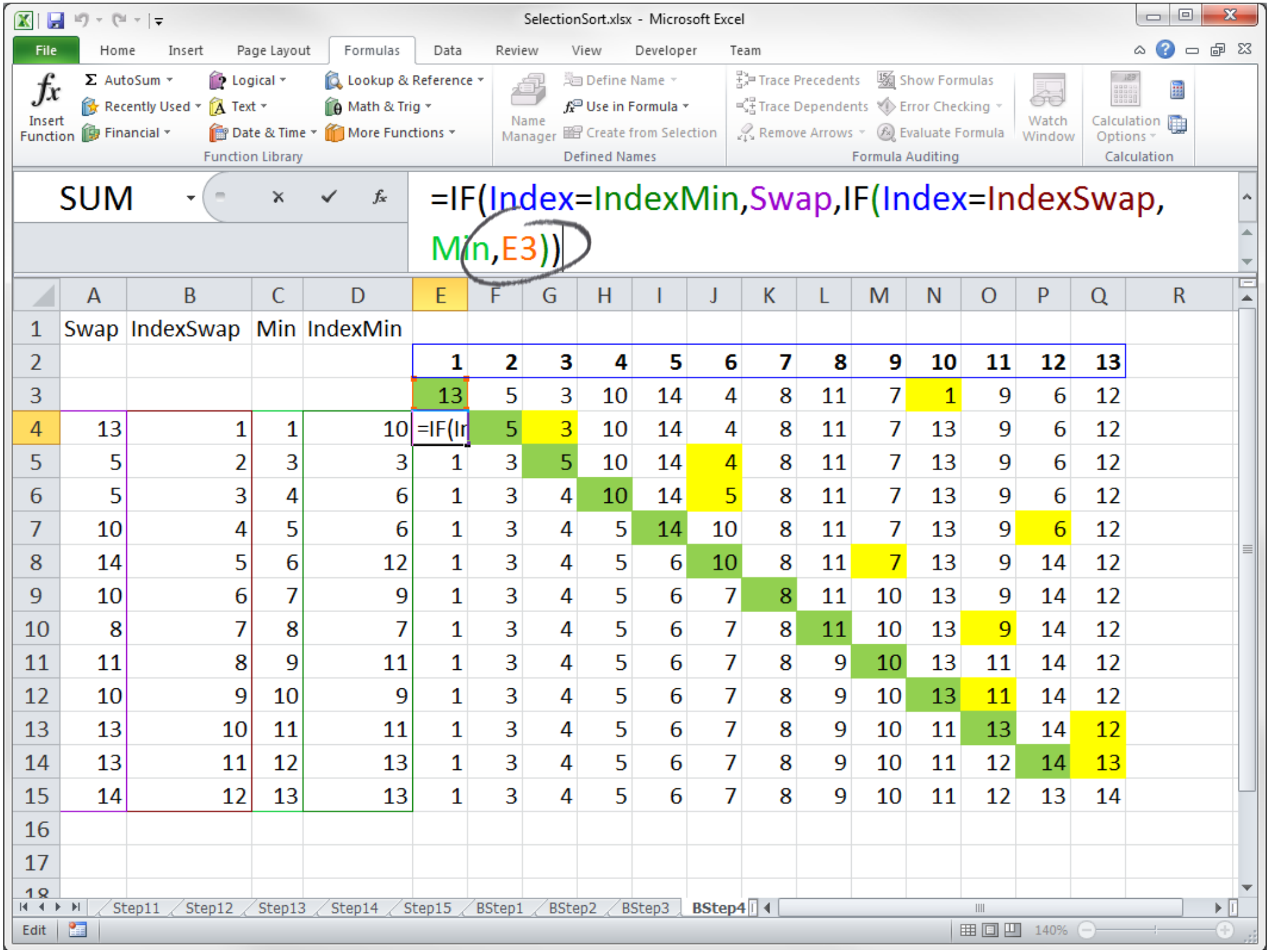

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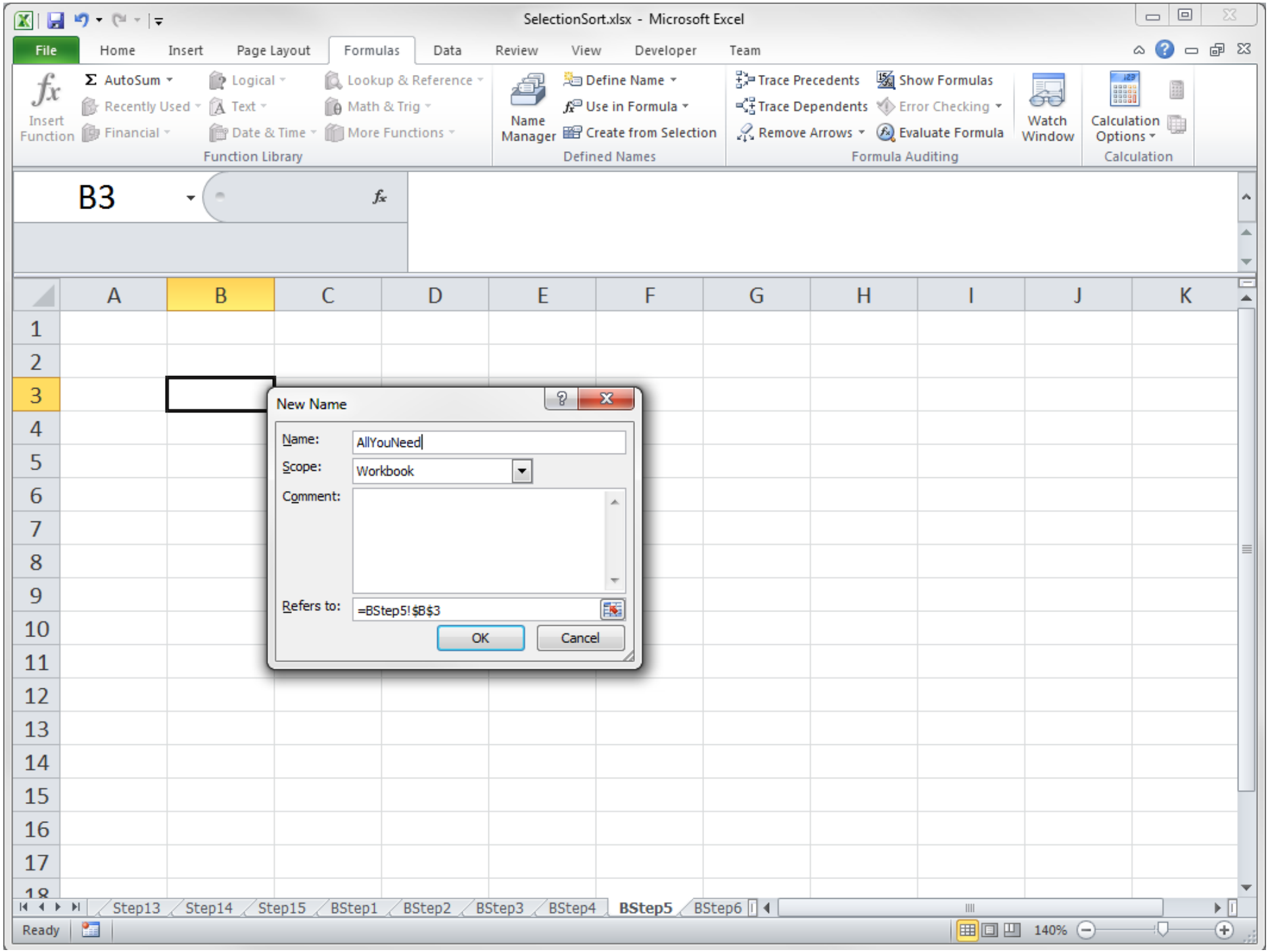
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Name:
AllYouNeed
Scope:
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Comment:
Refers to:
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Cancel
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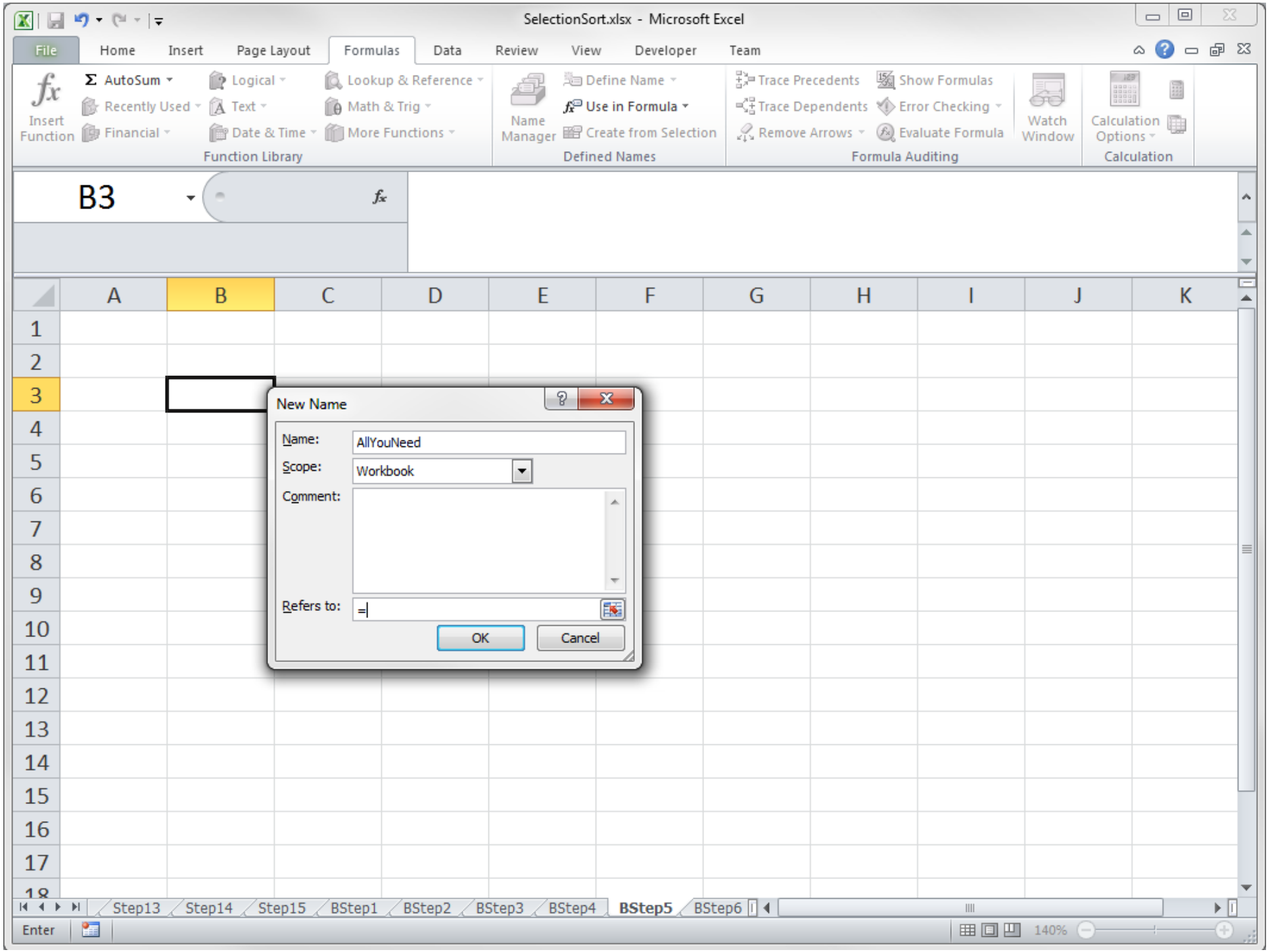
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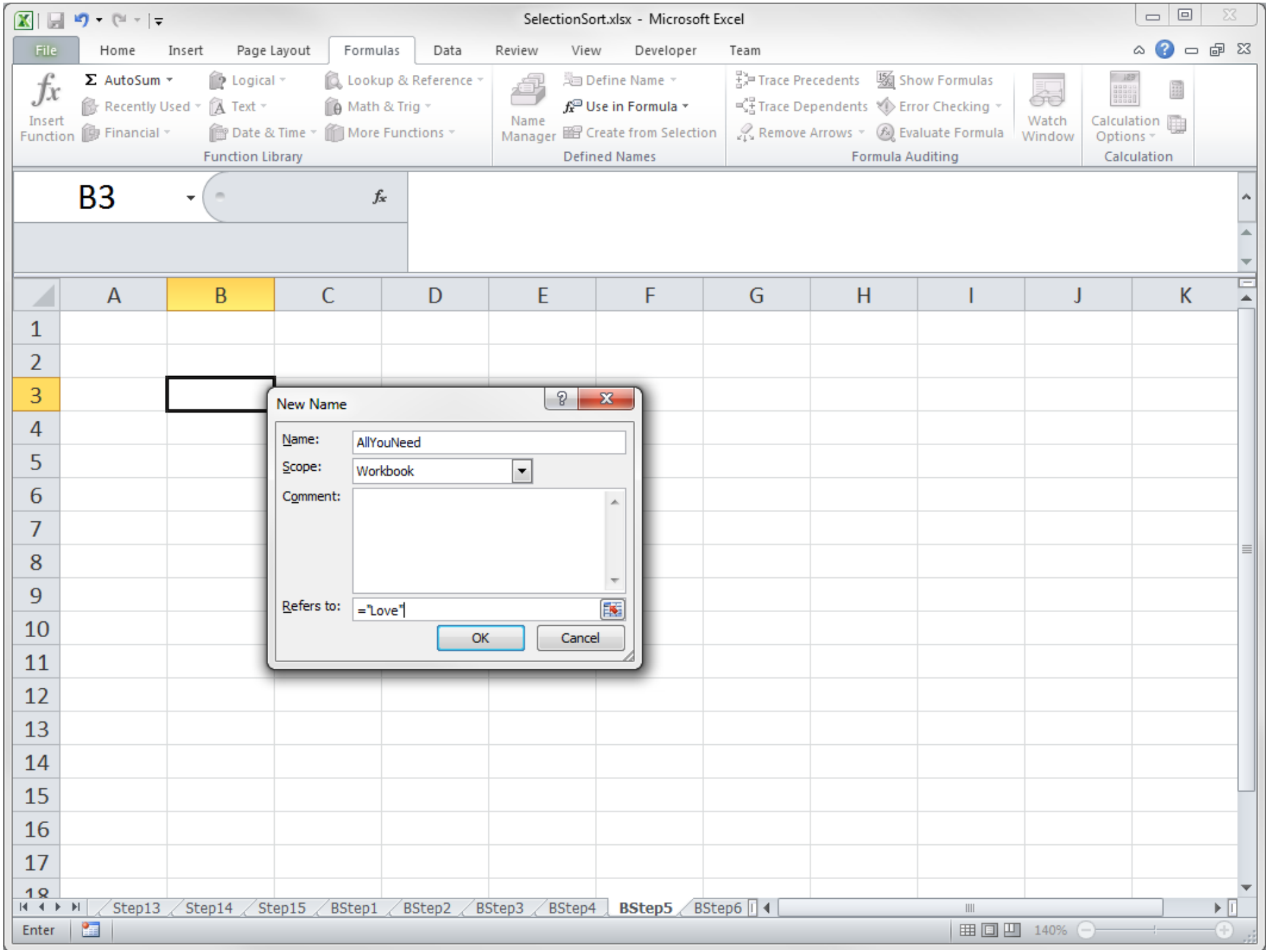
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Calculation
B3
New Name
Name: AllYouNeed
Scope: Workbook
Comment:
Refers to: ="Love"
OK
Cancel
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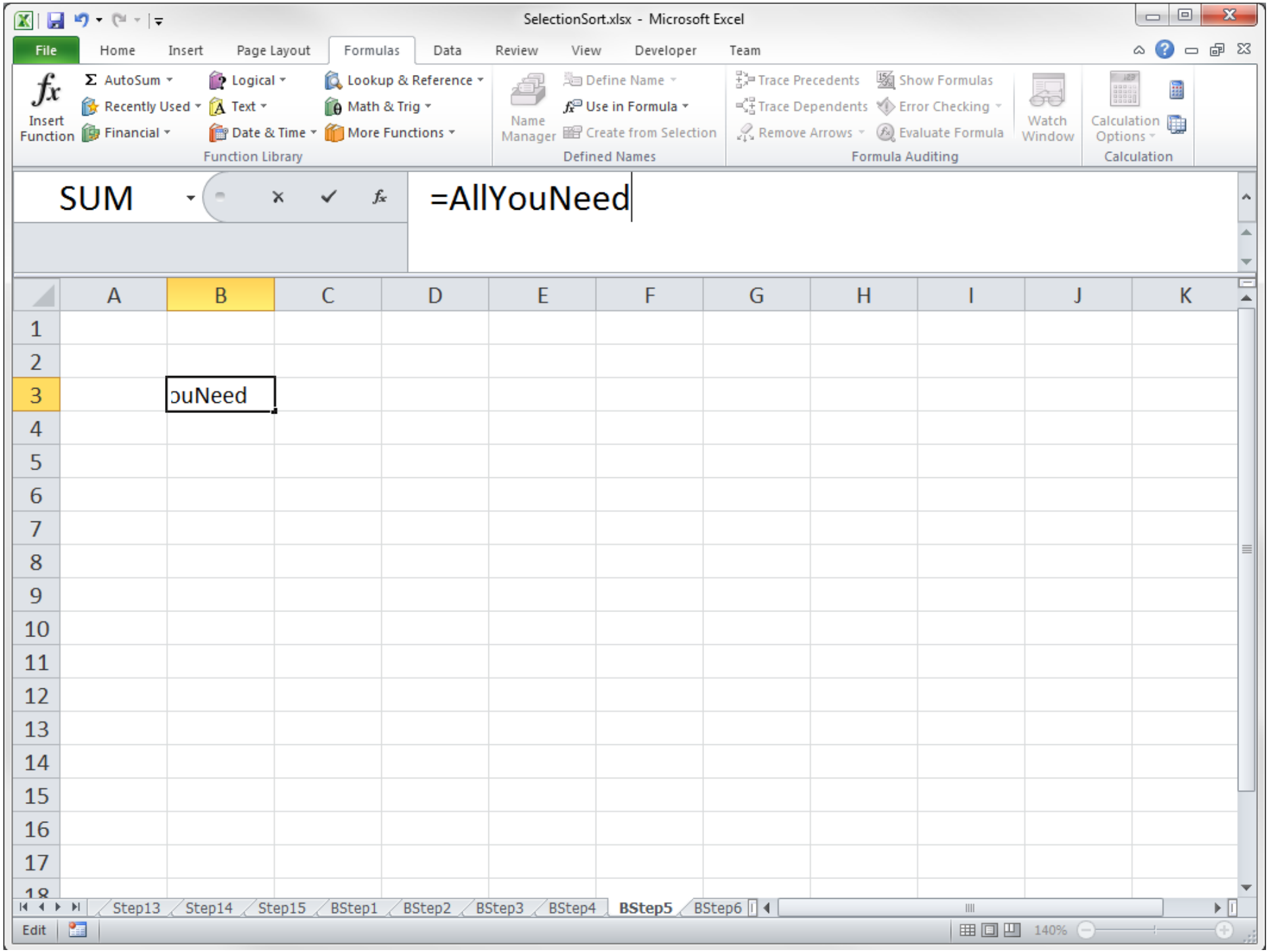
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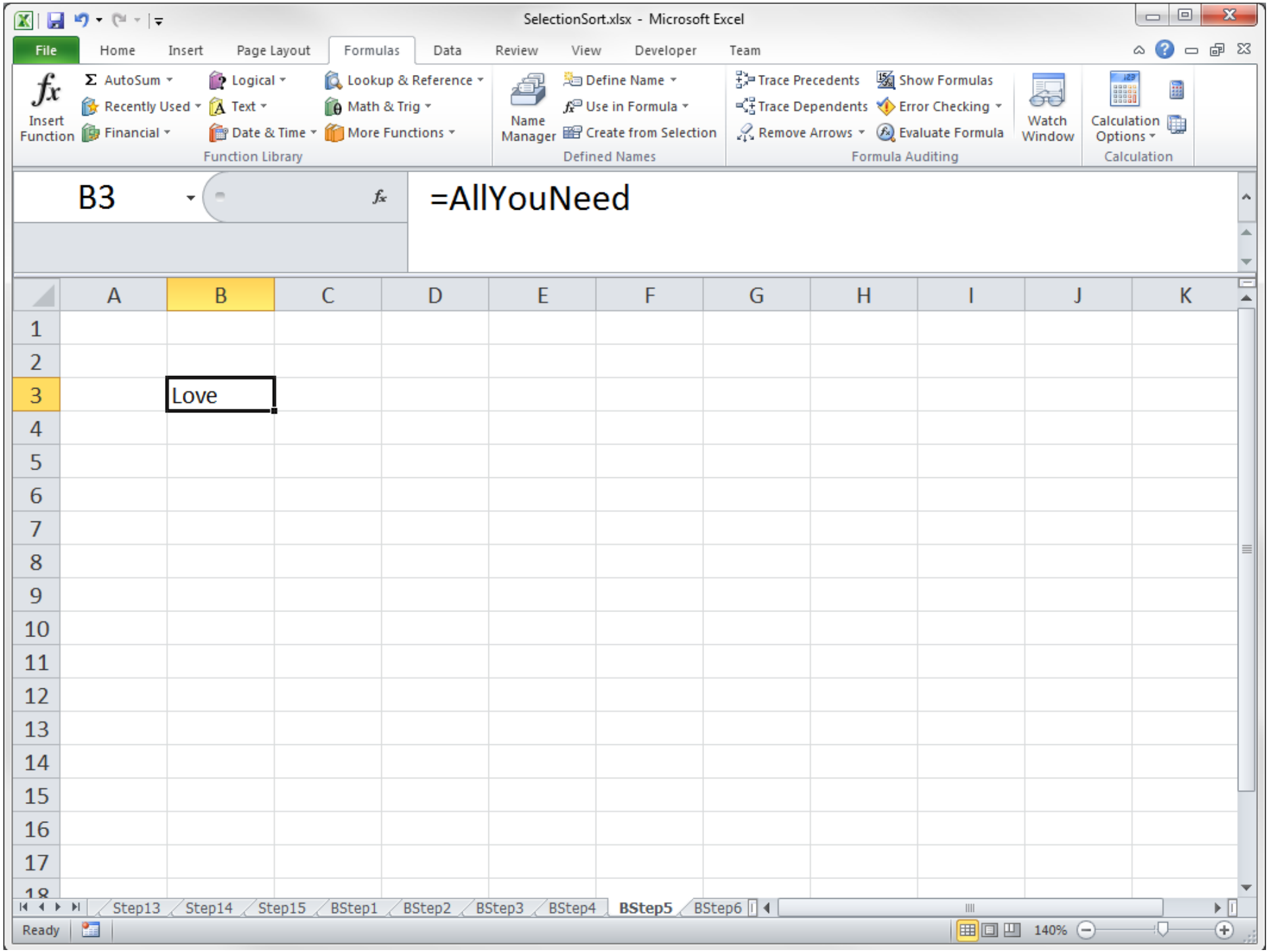
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Step13
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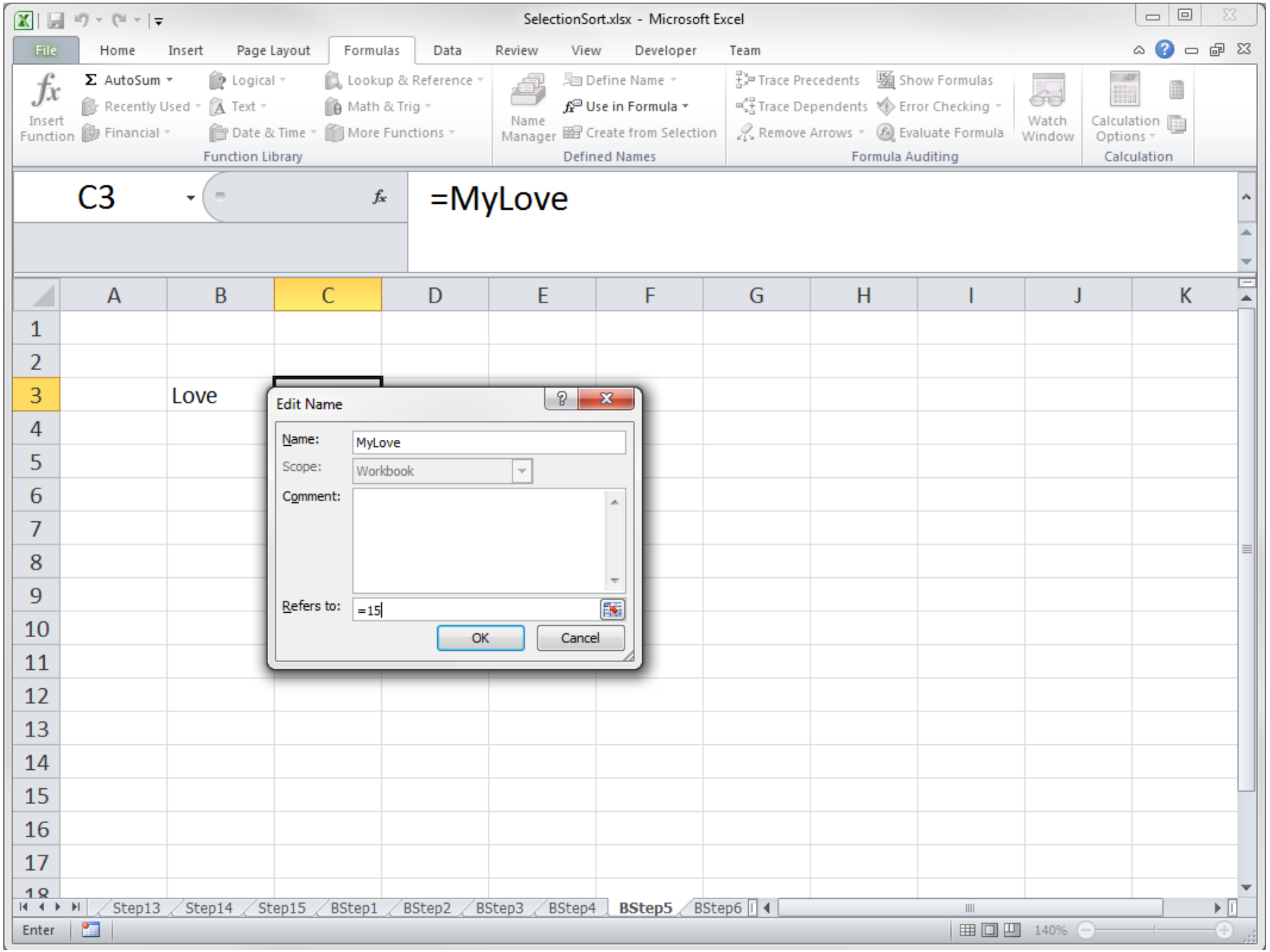
Paolo Nutini
these streets
However much I love you, you will always love me more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C3
=MyLove
Love
Edit Name
Name:
MyLove
Scope:
Workbook
Comment:
Refers to:
=15
OK
Cancel
Step13
Step14
Step15
BStep1
BStep2
BStep3
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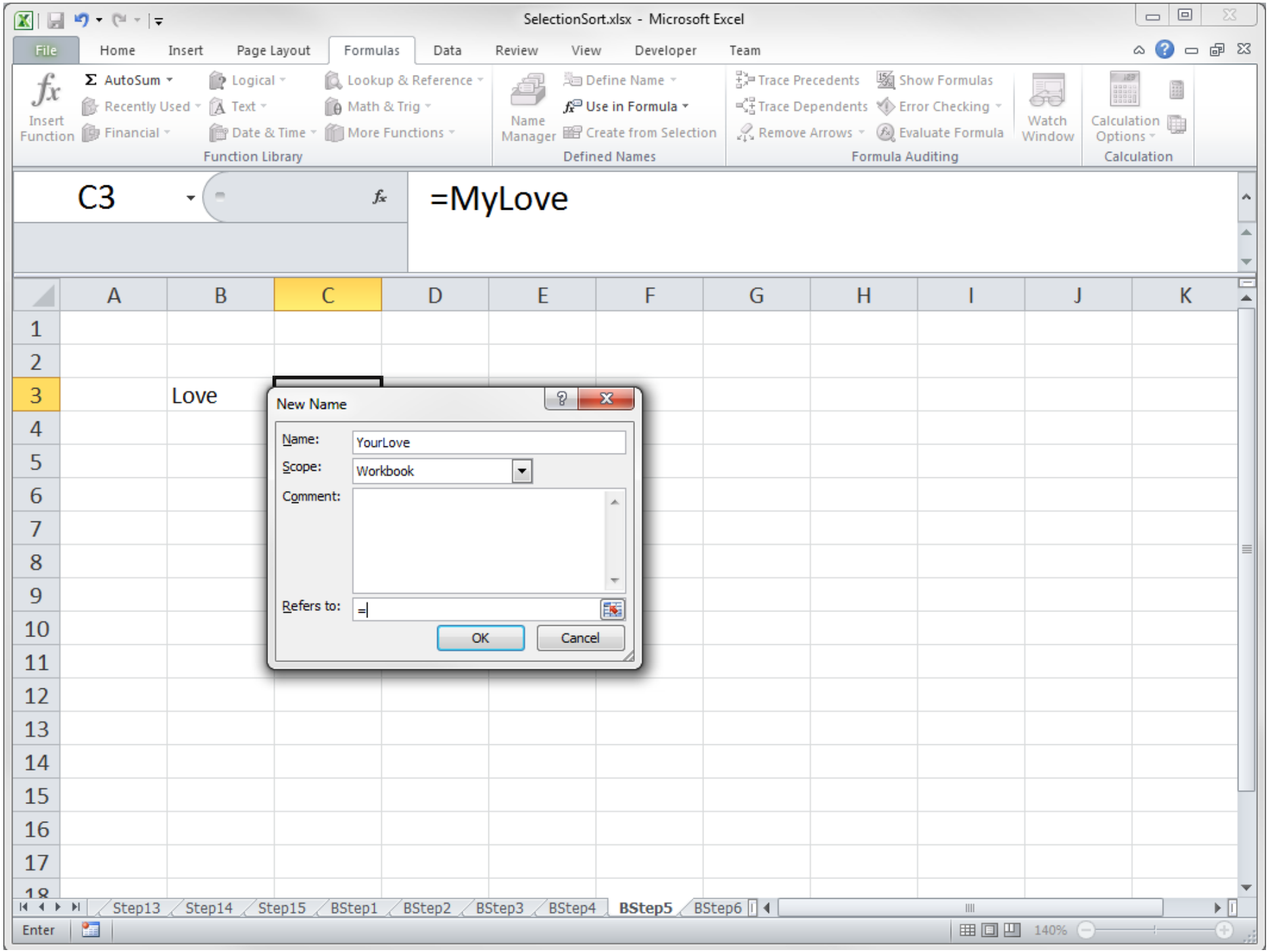
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C3
=MyLove
Love
New Name
Name: YourLove
Scope: Workbook
Comment:
Refers to: =
OK
Cancel
Step13
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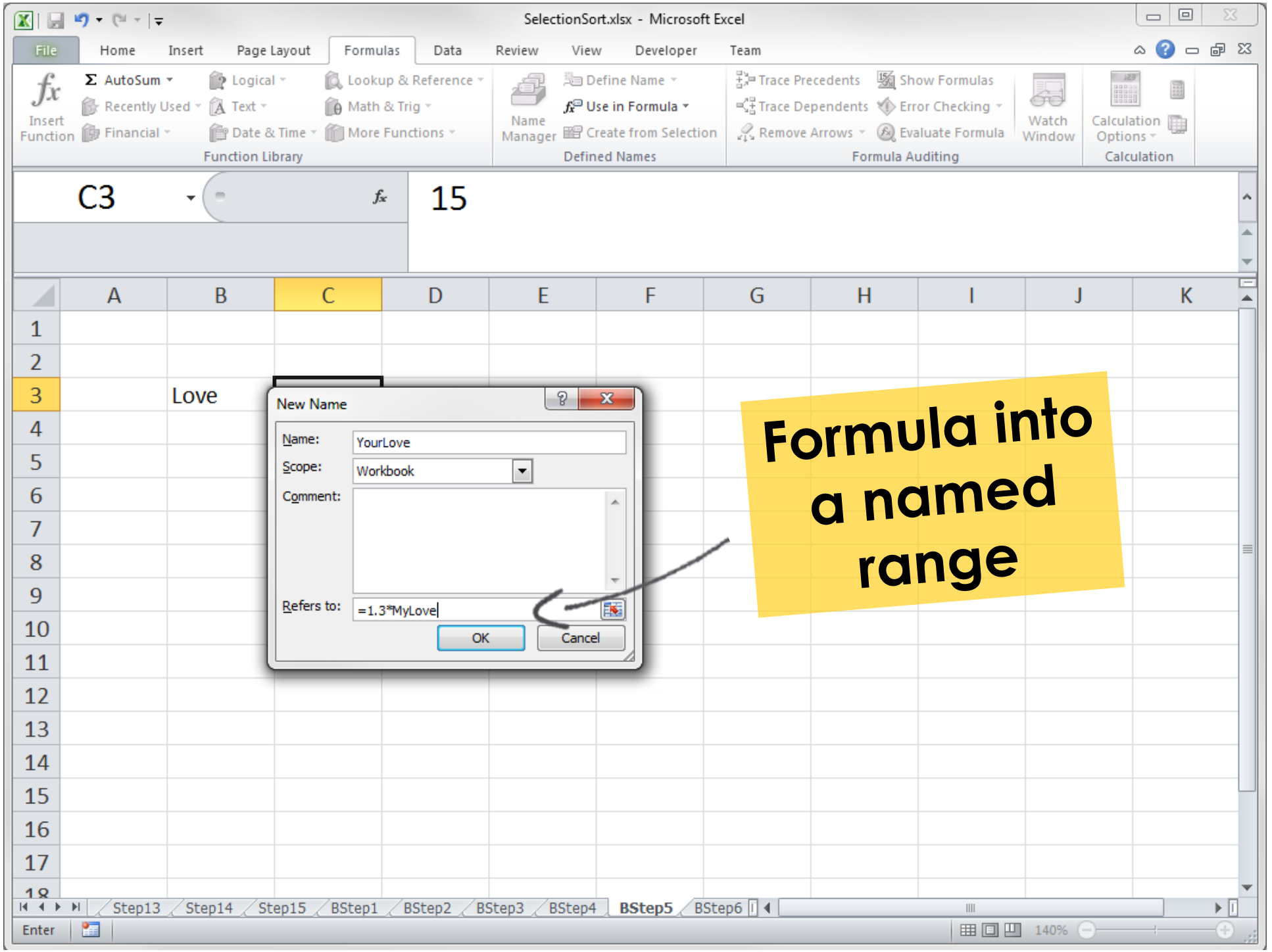
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Trace Precedents
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C3
15
Love
New Name
Name: YourLove
Scope: Workbook
Comment:
Refers to: =1.3*MyLove
OK
Cancel
Formula into a named range
Step13
Step14
Step15
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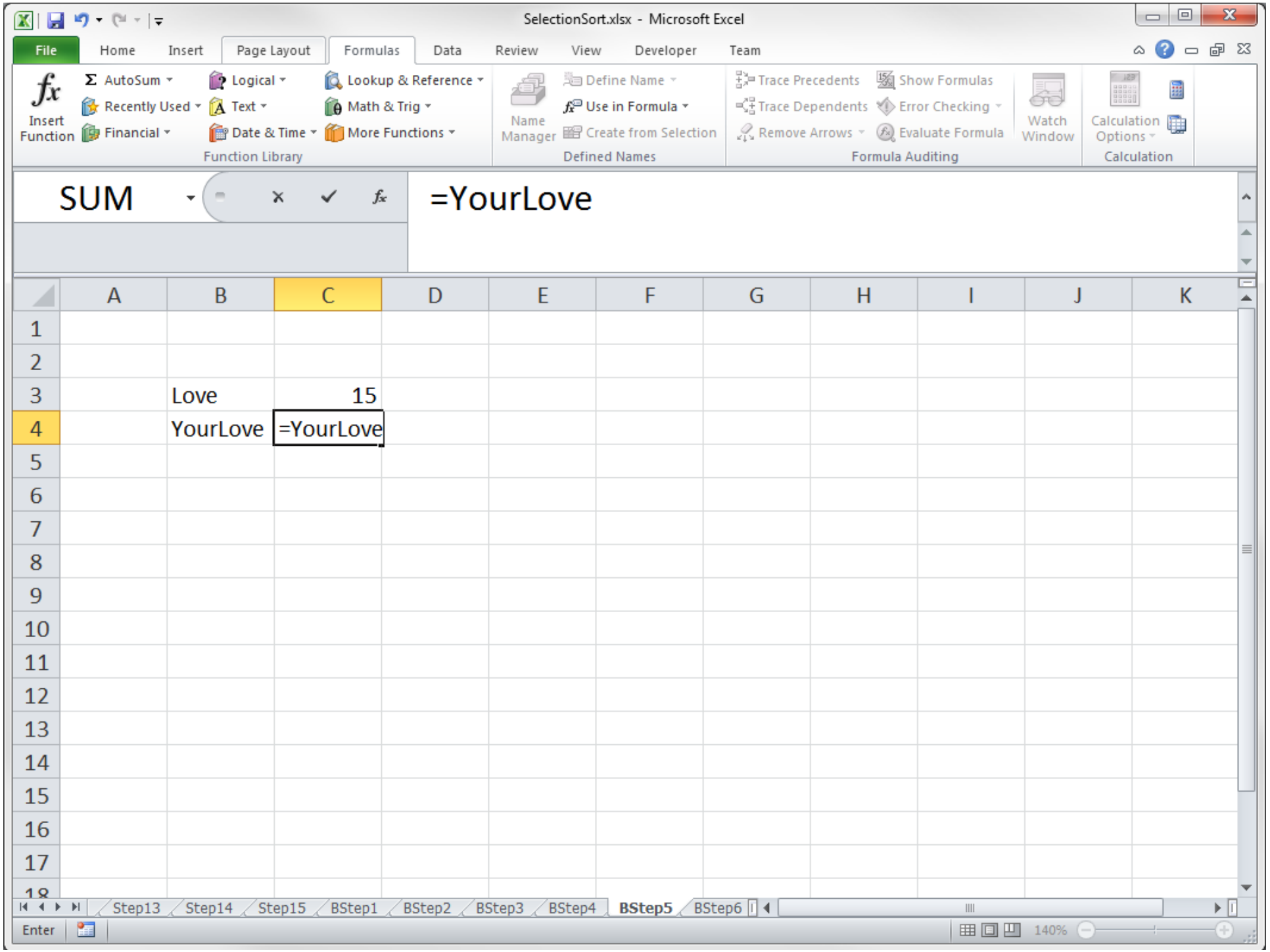
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More Functions
Function Library
Name Manager
Define Name
Use in Formula
Create from Selection
Defined Names
Trace Precedents
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SUM
=YourLove
A B C D E F G H I J K
1
2
3 Love 15
4 YourLove =YourLove
5 6 7 8 9 10 11 12 13 14 15 16 17 18
Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6
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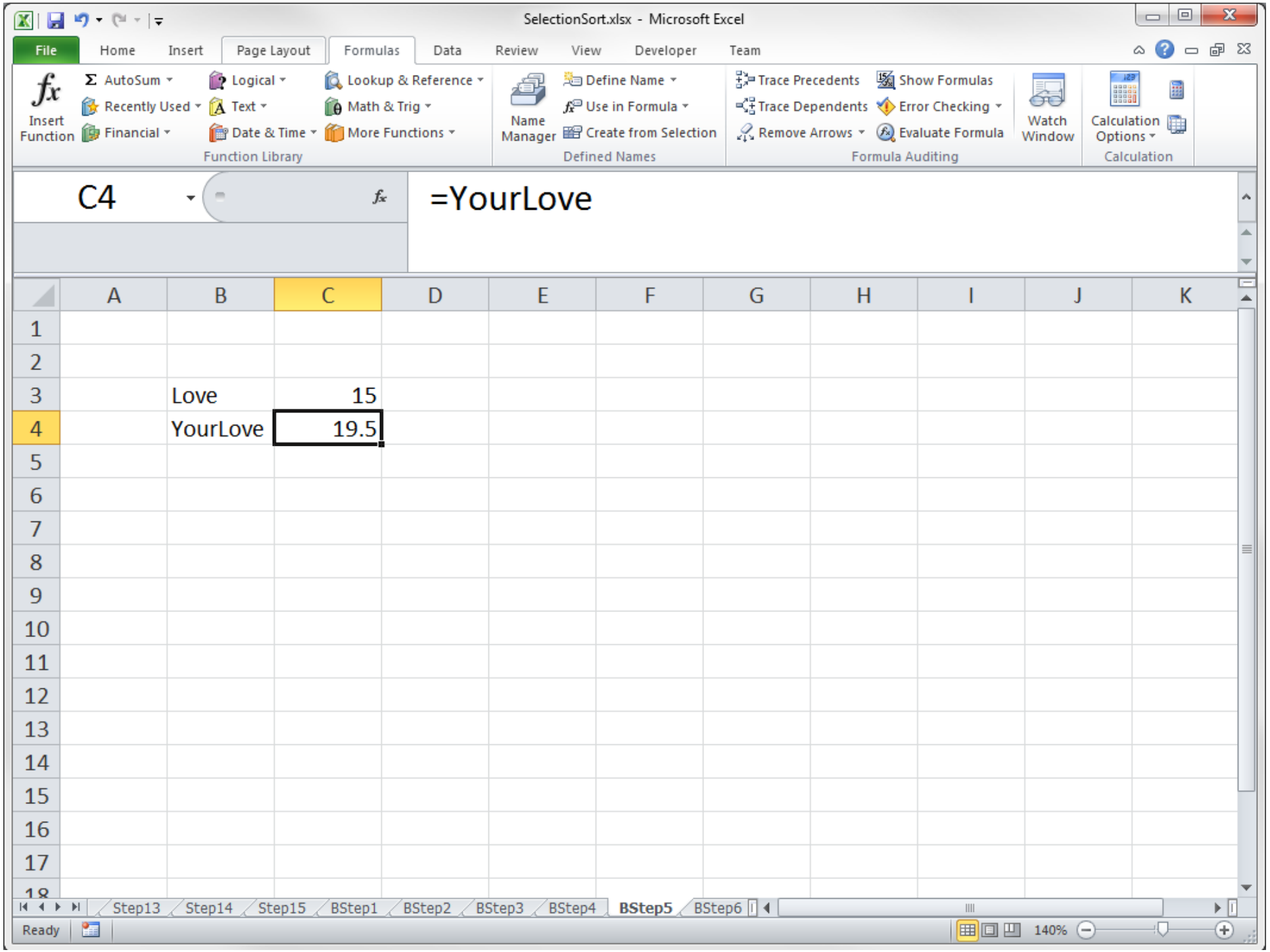
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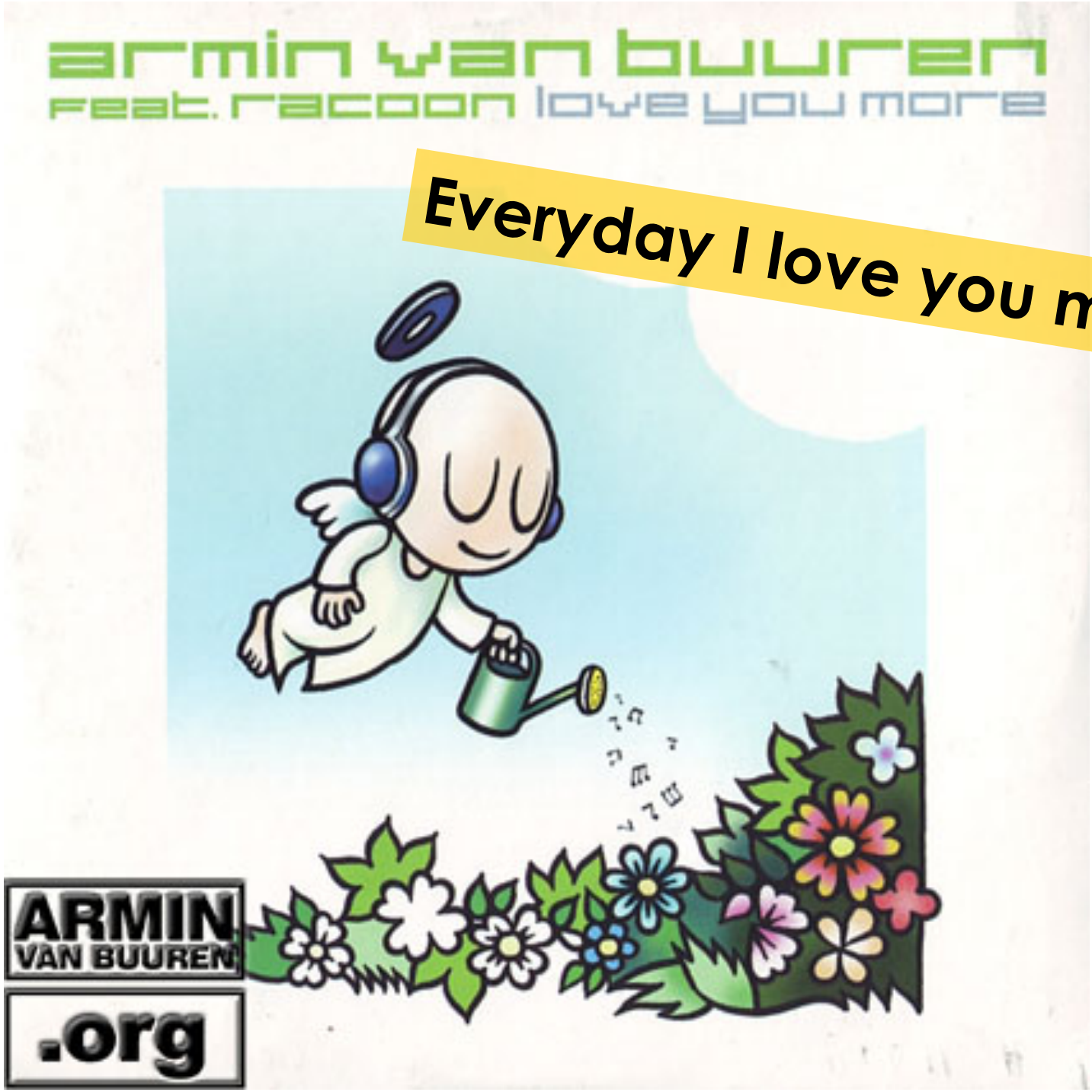
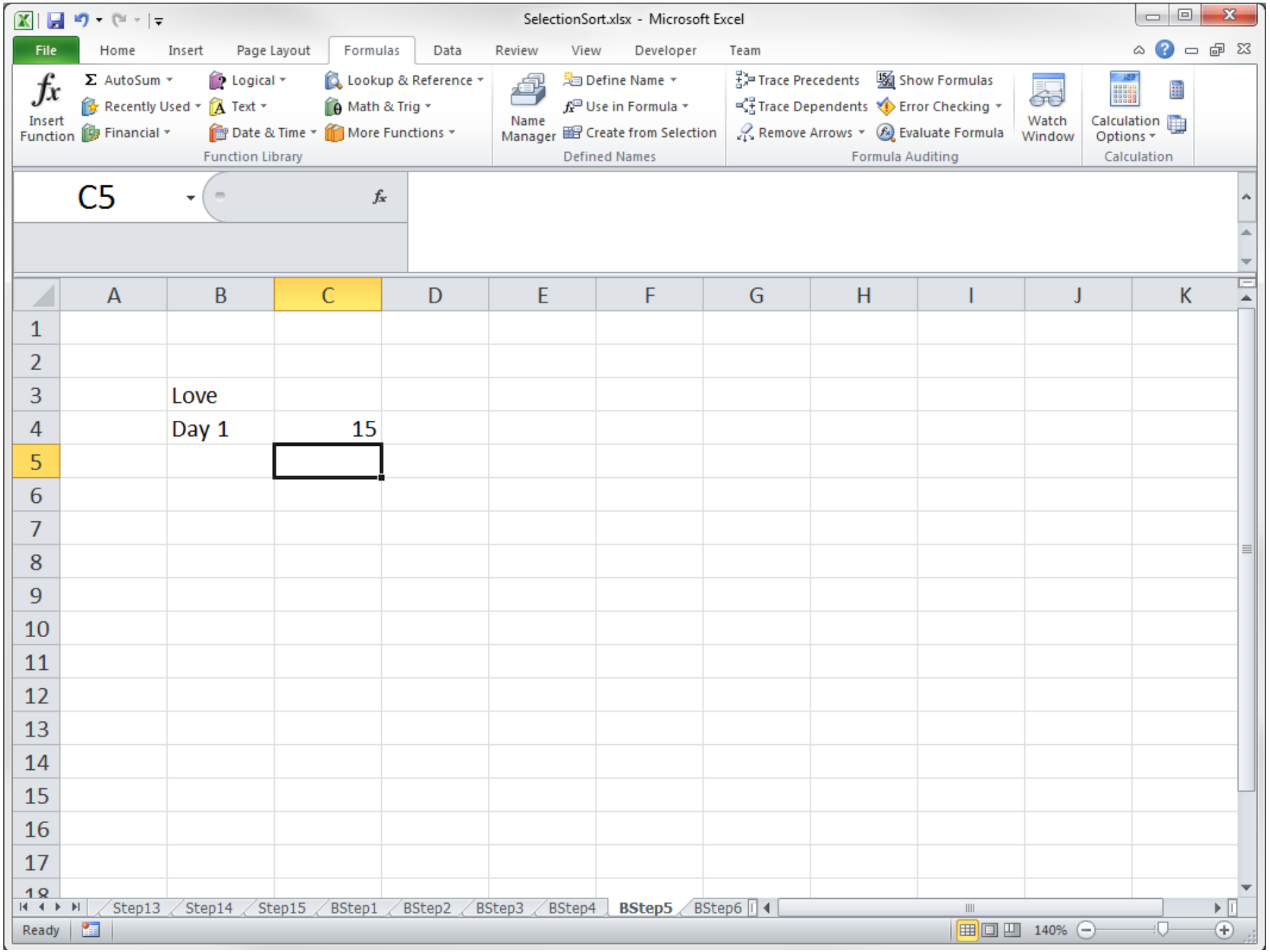
More Functions
Function Library
Name Manager
Define Name
Use in Formula
Create from Selection
Defined Names
Trace Precedents
Trace Dependents
Remove Arrows
Show Formulas
Error Checking
Evaluate Formula
Formula Auditing
Watch Window
Calculation Options
Calculation
C4
=YourLove
A B C D E F G H I J K
1
2
3 Love 15
4 YourLove 19.5
5 6 7 8 9 10 11 12 13 14 15 16 17 18
Step13 Step14 Step15 BStep1 BStep2 BStep3 BStep4 BStep5 BStep6
Ready
140%

armin van buuren

feat. racoon love you more

Everyday I love you more

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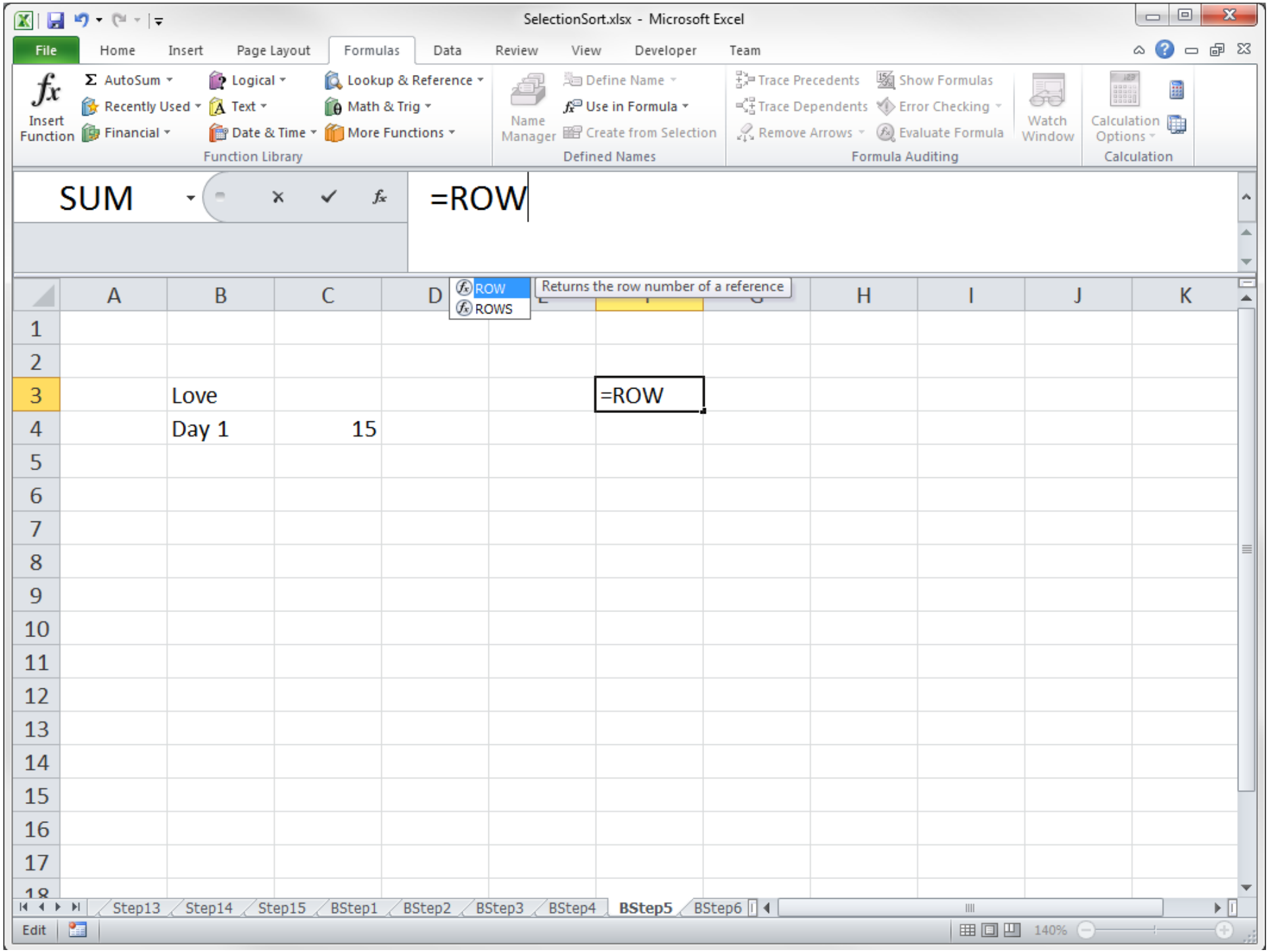
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=ROW
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ROWS
Returns the row number of a reference
A
B
C
D
H
I
J
K
Love
Day 1
15
=ROW
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Step15
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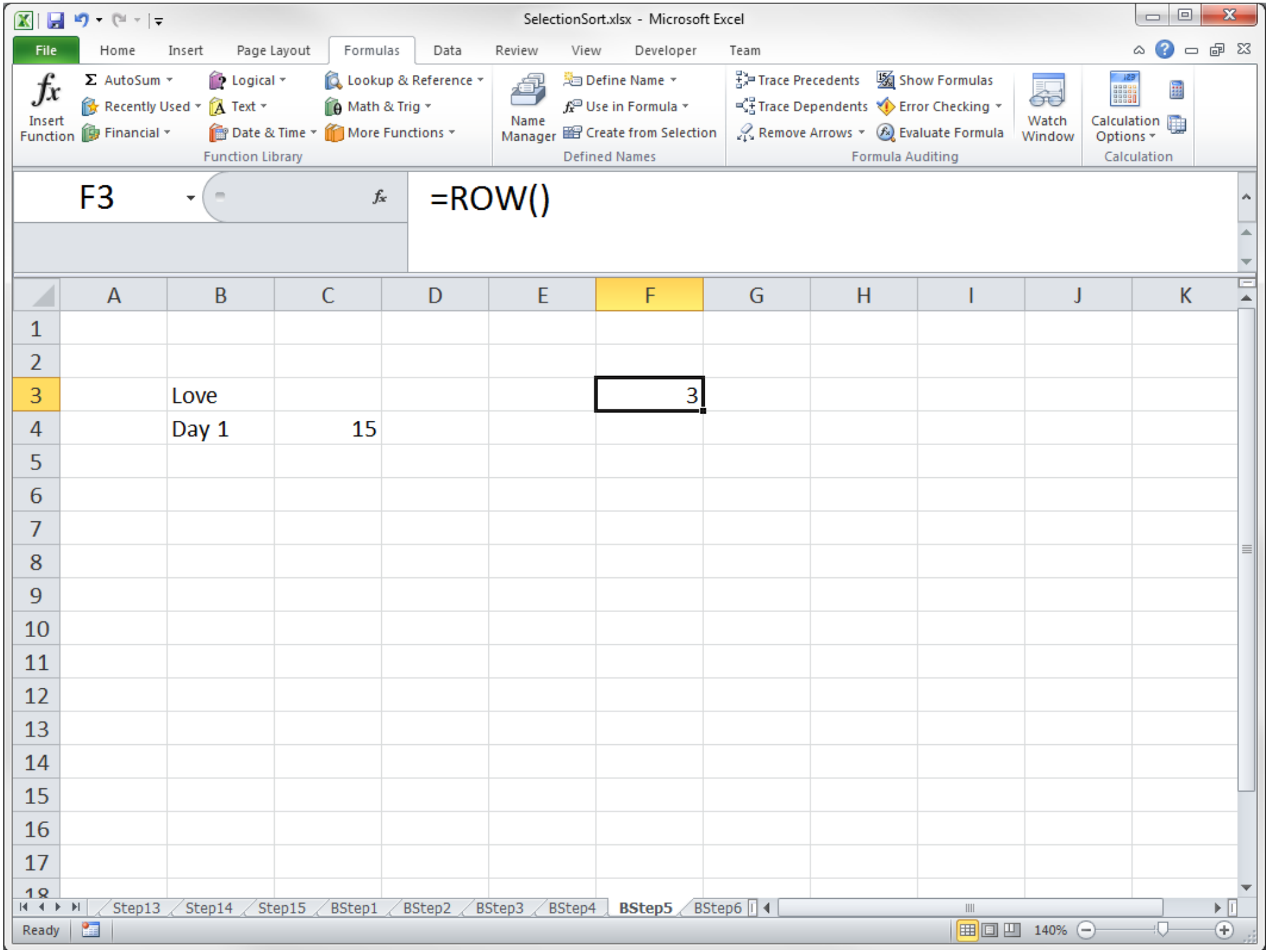
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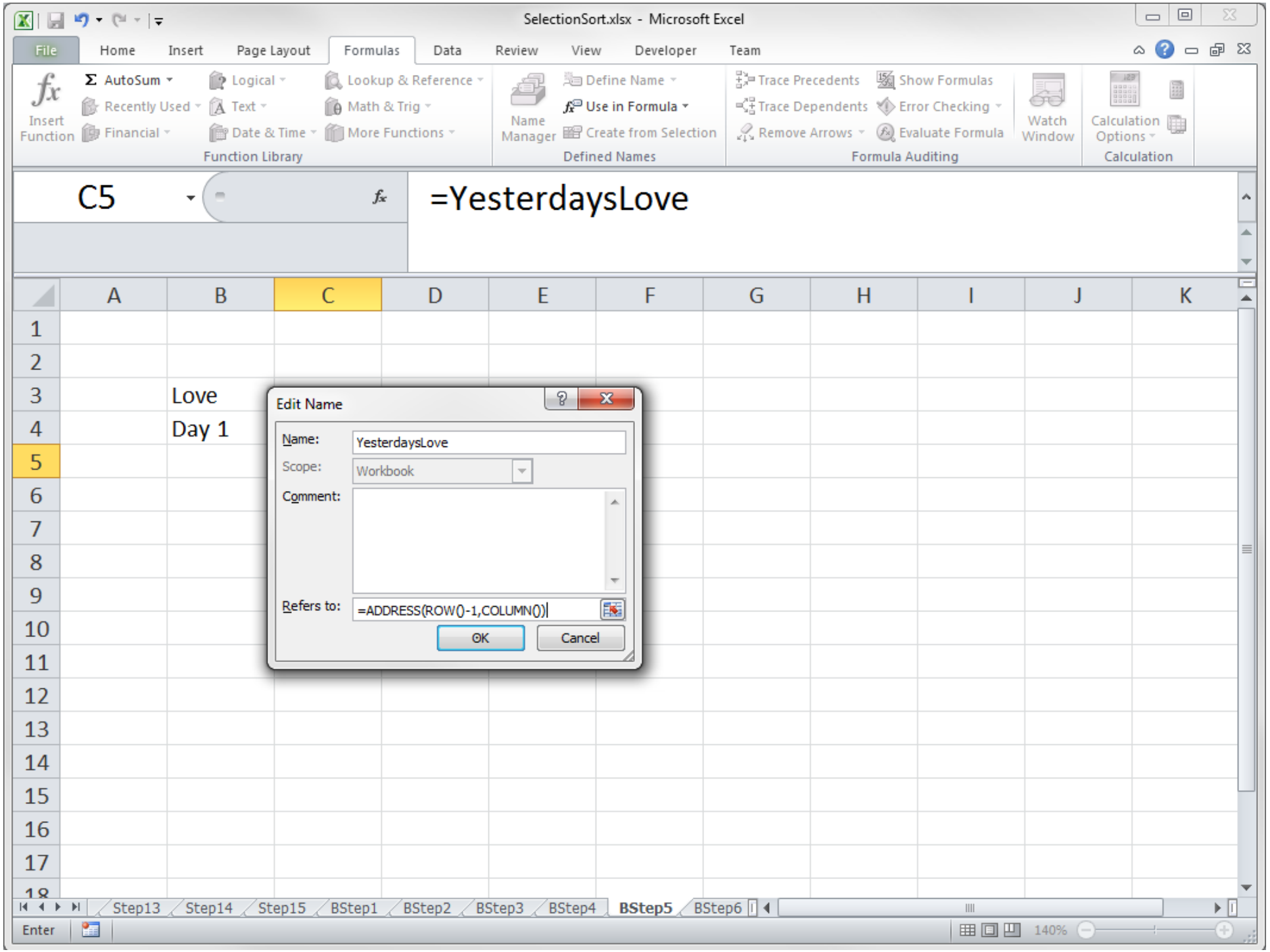
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Formula Auditing
Watch Window
Calculation Options
Calculation
C5
=YesterdaysLove
Love
Day 1
Edit Name
Name:
YesterdaysLove
Scope:
Workbook
Comment:
Refers to:
=ADDRESS(ROW()-1,COLUMN())
OK
Cancel
Step13
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Step15
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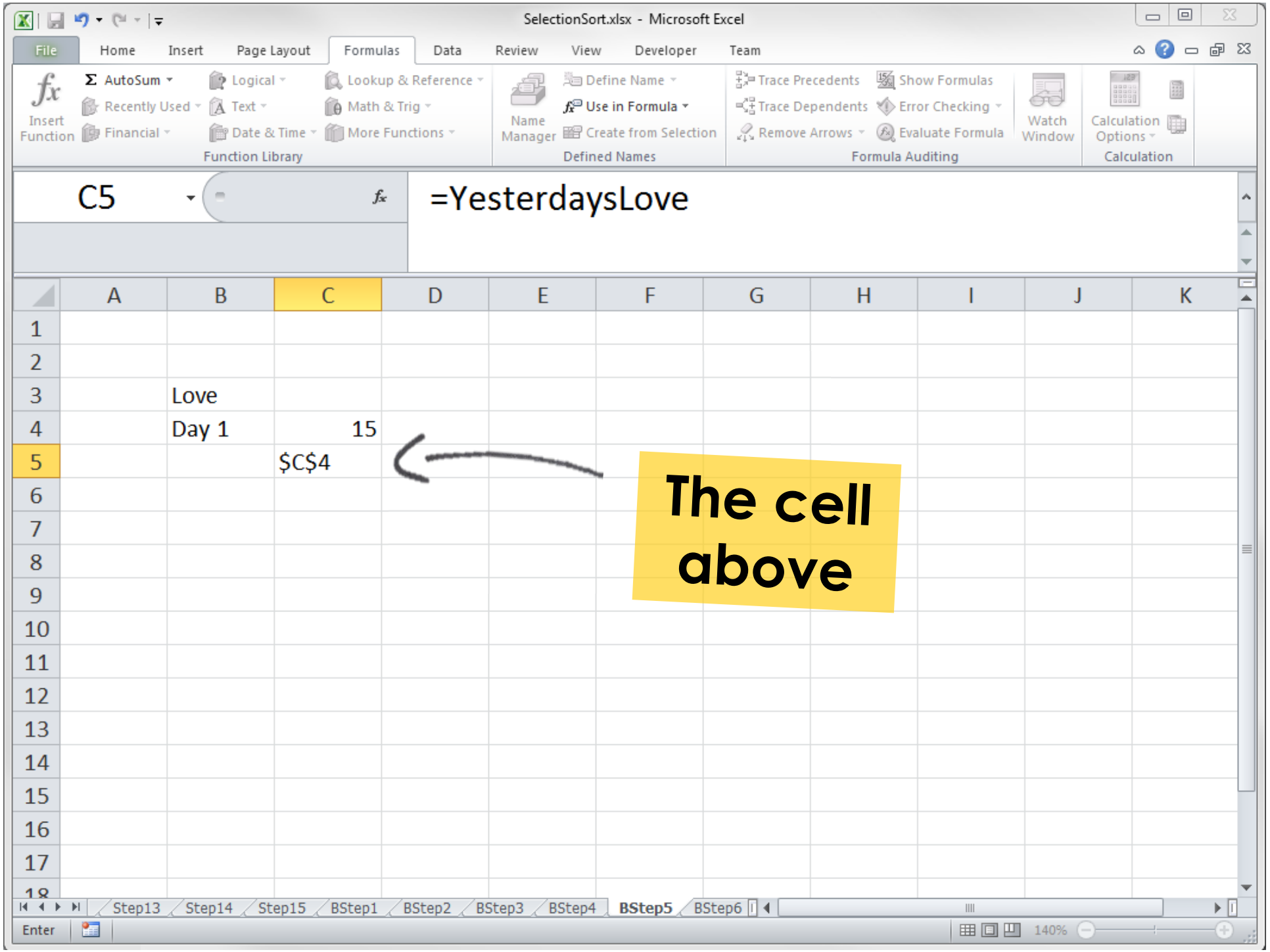
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16
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Step14
Step15
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BStep2
BStep3
BStep4
BStep5
BStep6
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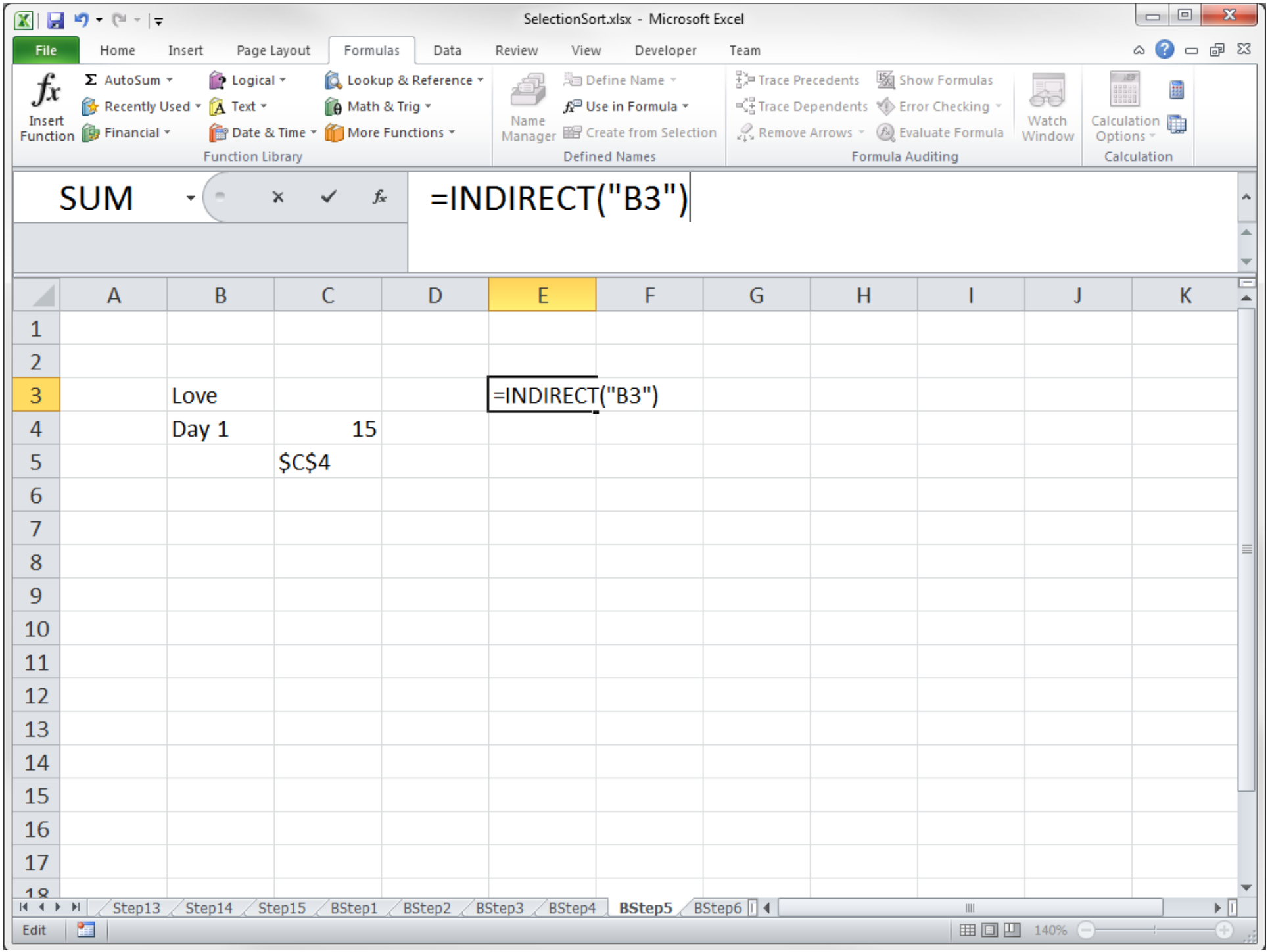
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Calculation Options
Calculation
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=INDIRECT("B3")
Love
Day 1
15
$C$4
=INDIRECT("B3")
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Step15
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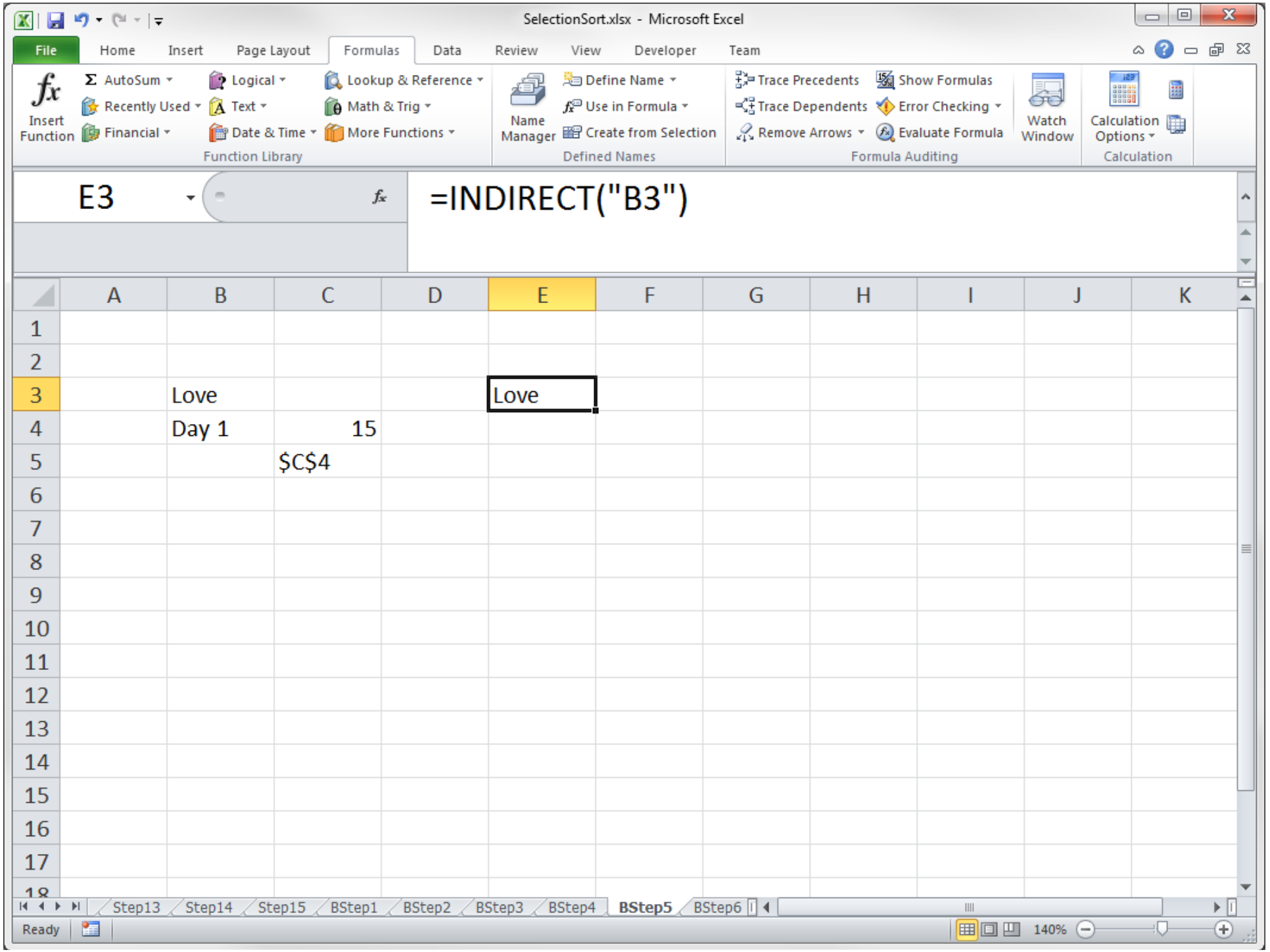
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Formula Auditing
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Calculation Options
Calculation
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=INDIRECT("B3")
Love
Day 1
15
$C$4
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Step13
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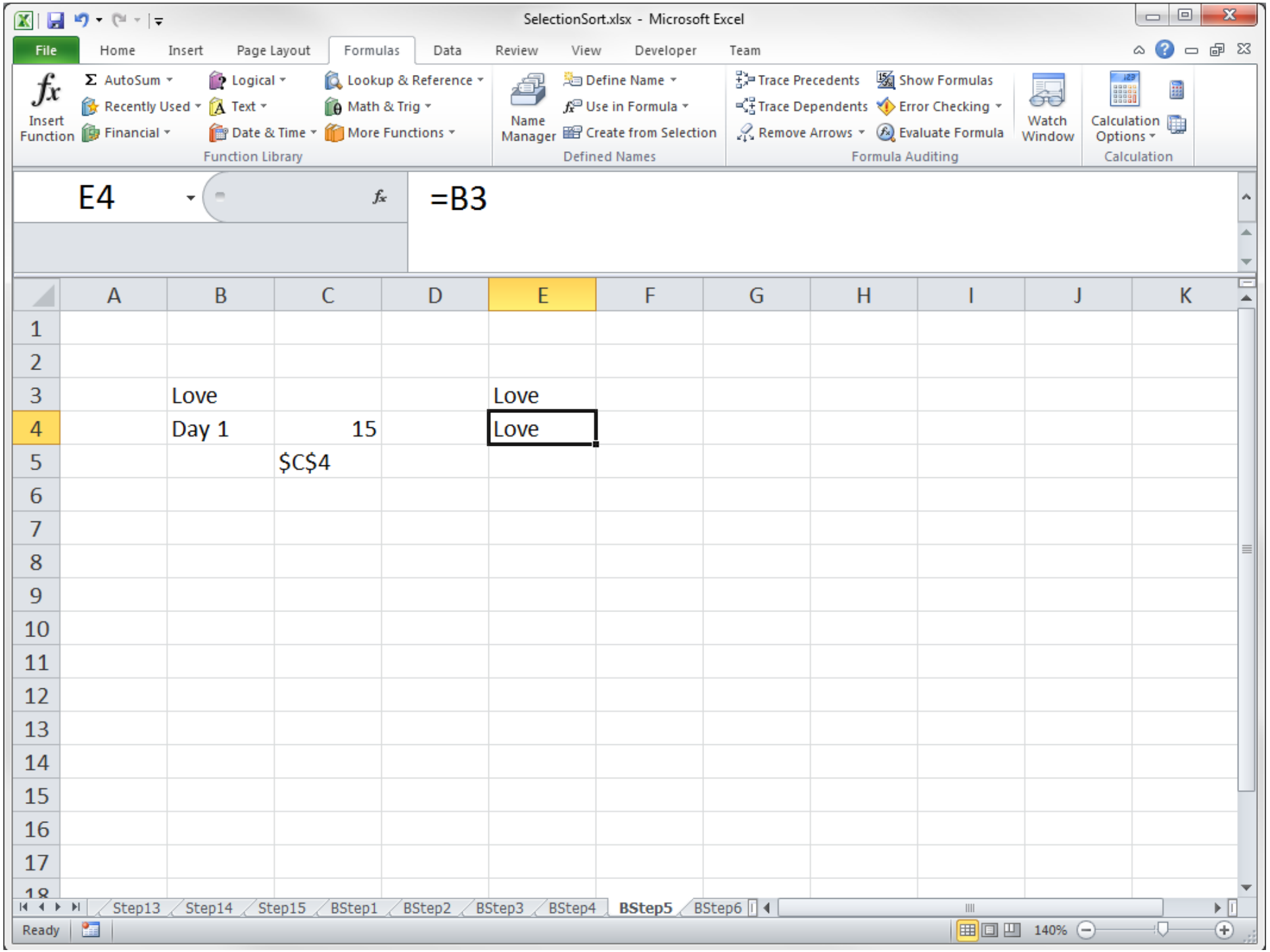
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Love
Day 1
15
$C$4
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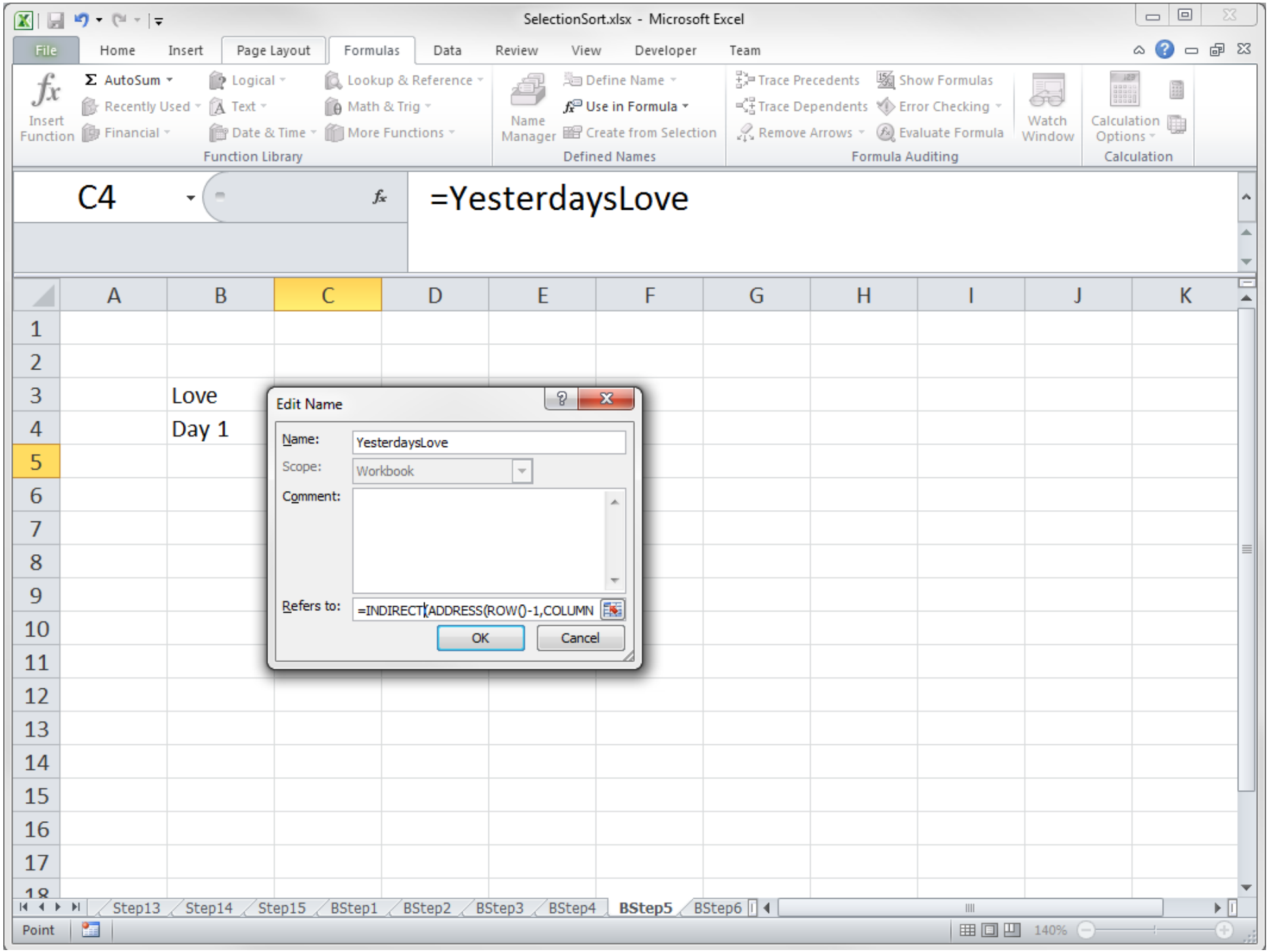
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Evaluate Formula
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Calculation Options
Calculation
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=YesterdaysLove
Love
Day 1
Edit Name
Name:
YesterdaysLove
Scope:
Workbook
Comment:
Refers to:
=INDIRECT(ADDRESS(ROW()-1,COLUMN
OK
Cancel
Step13
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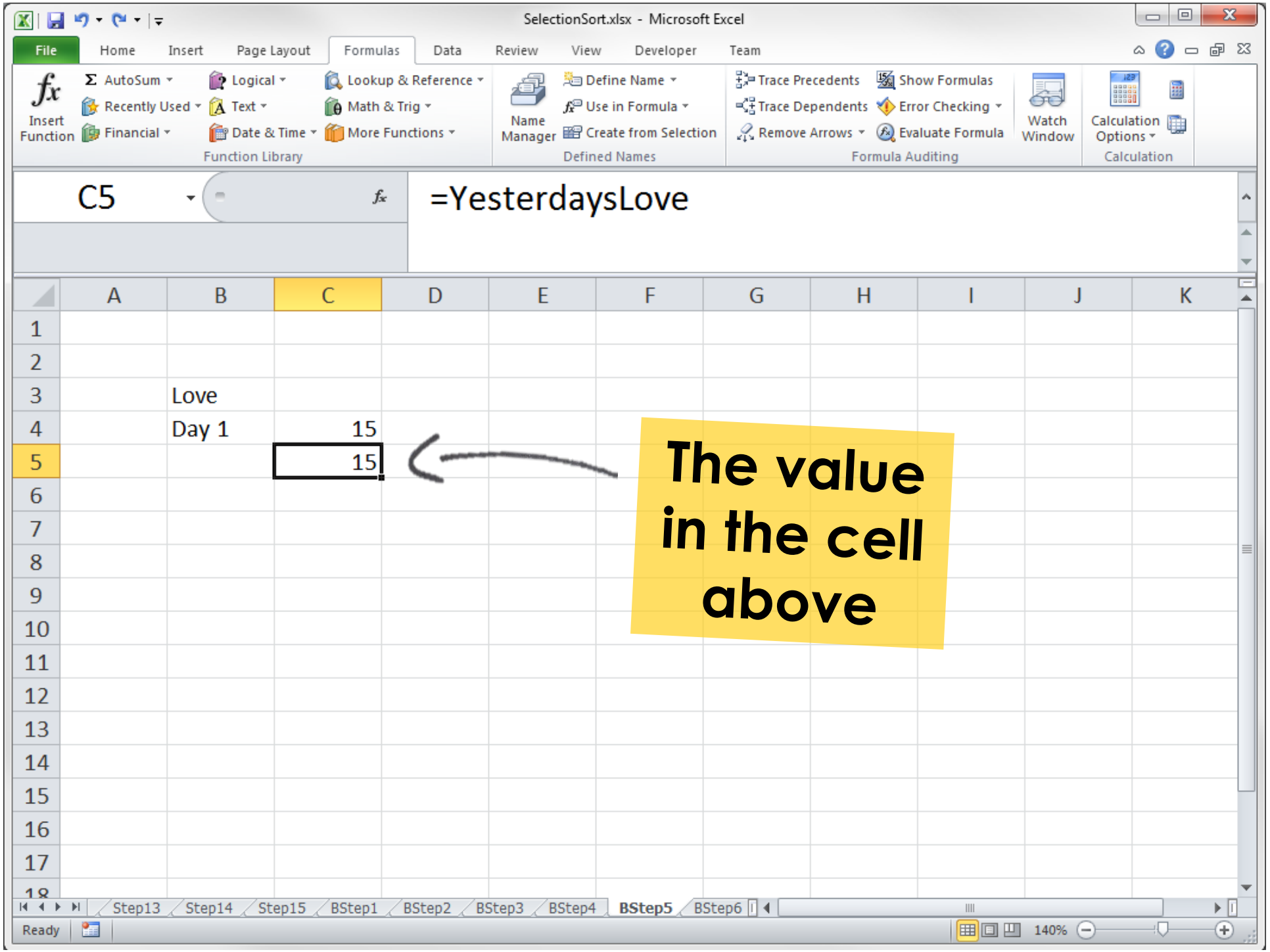
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=YesterdaysLove
Love
Day 1
15
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The value in the cell above
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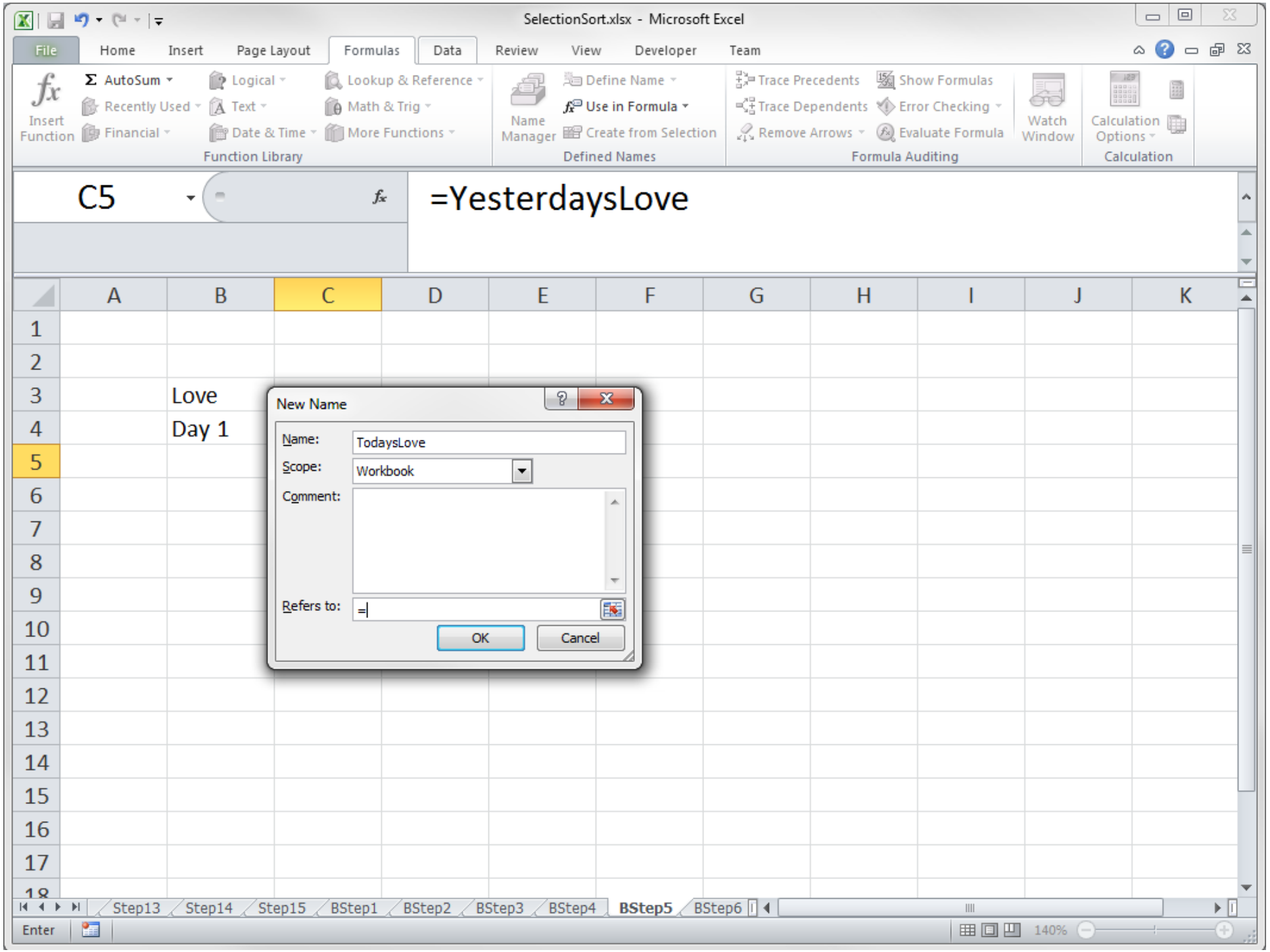
BStep3
BStep4
BStep5
BStep6
Ready
140%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Day 1
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TodaysLove
Scope:
Workbook
Comment:
Refers to:
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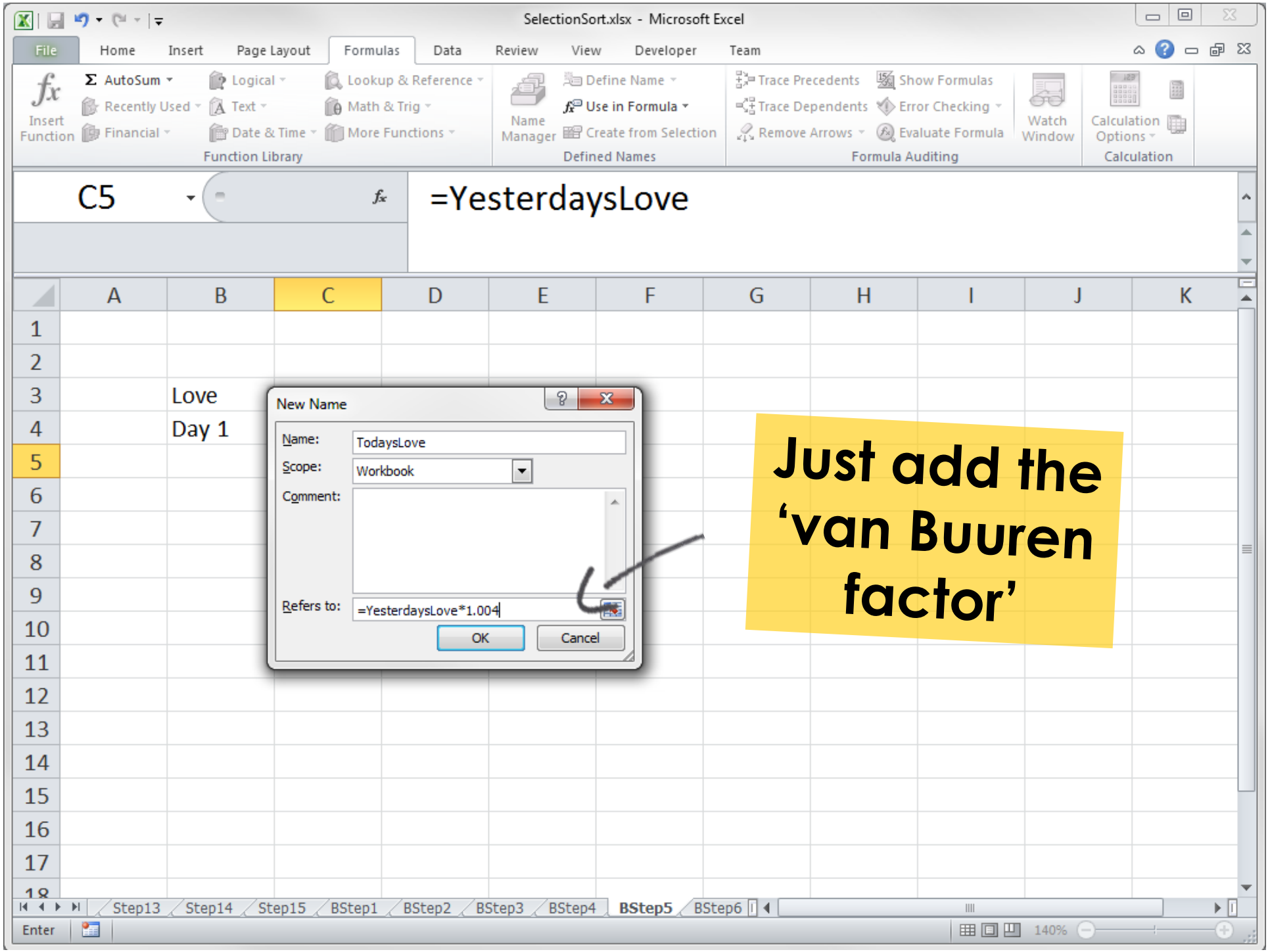
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Day 1
New Name
Name:
TodaysLove
Scope:
Workbook
Comment:
Refers to:
=YesterdaysLove*1.004
OK
Cancel
Just add the 'van Buuren factor'
Step13
Step14
Step15
BStep1
BStep2
BStep3
BStep4
BStep5
BStep6
Enter
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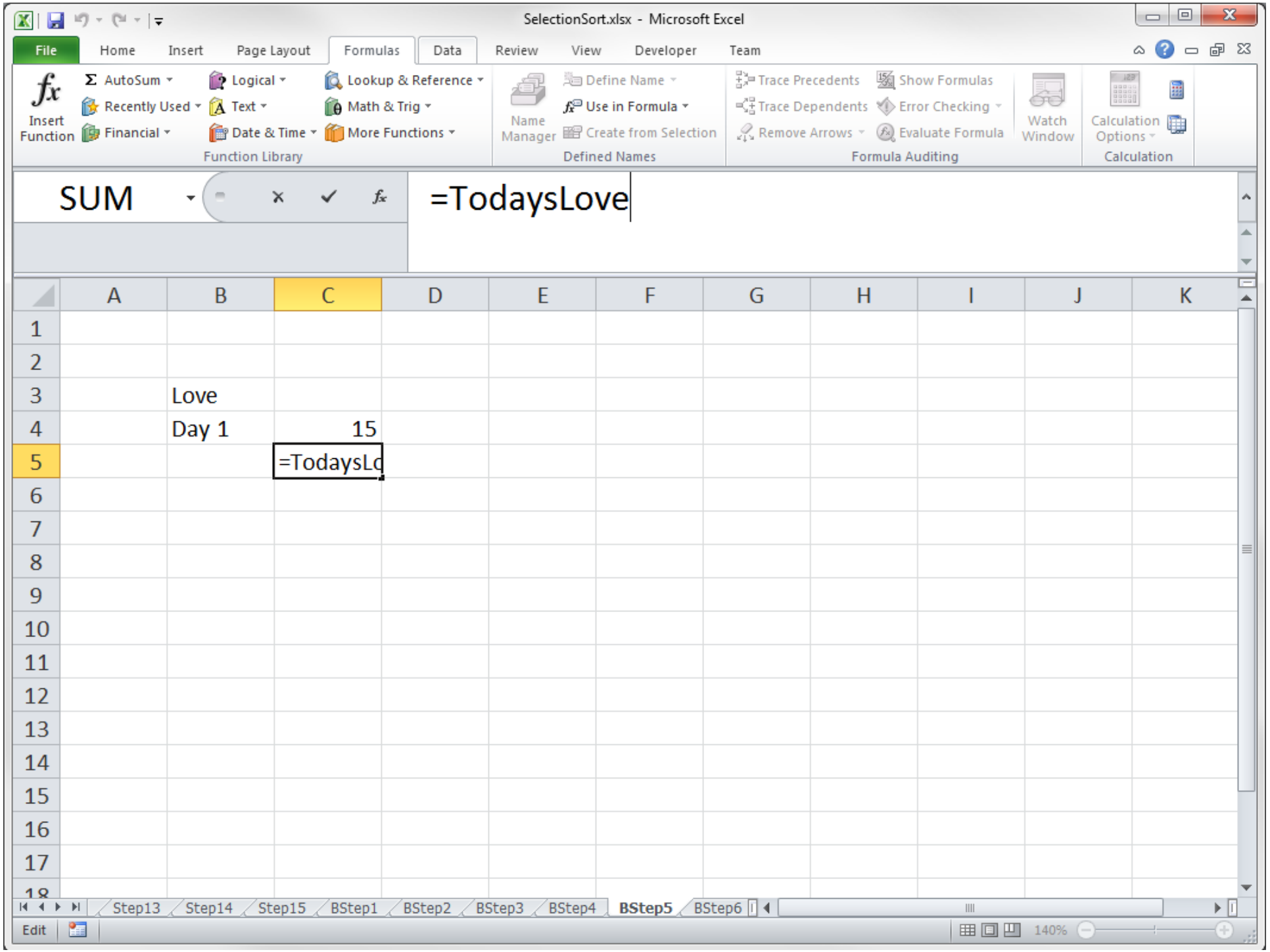
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Love
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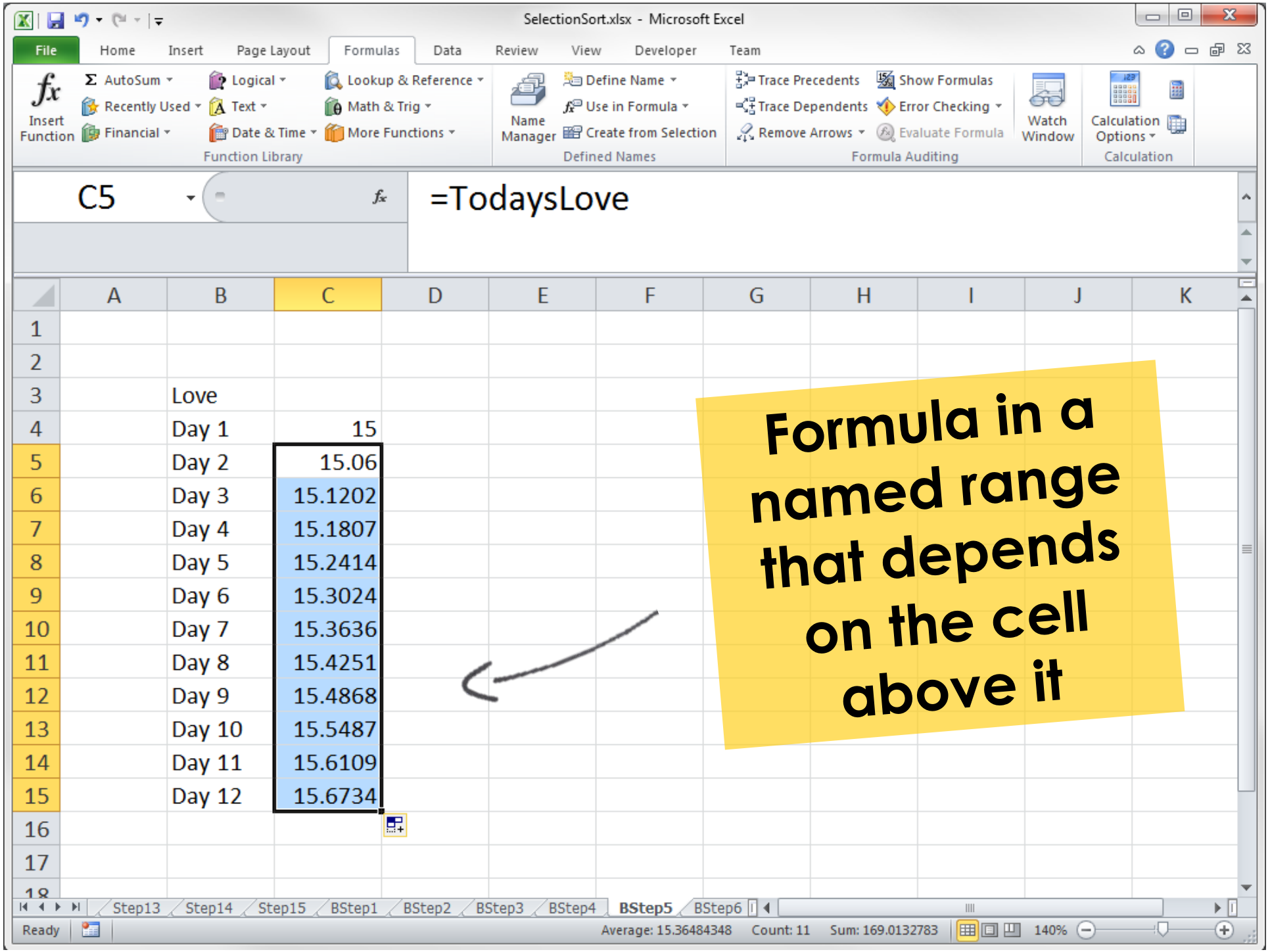
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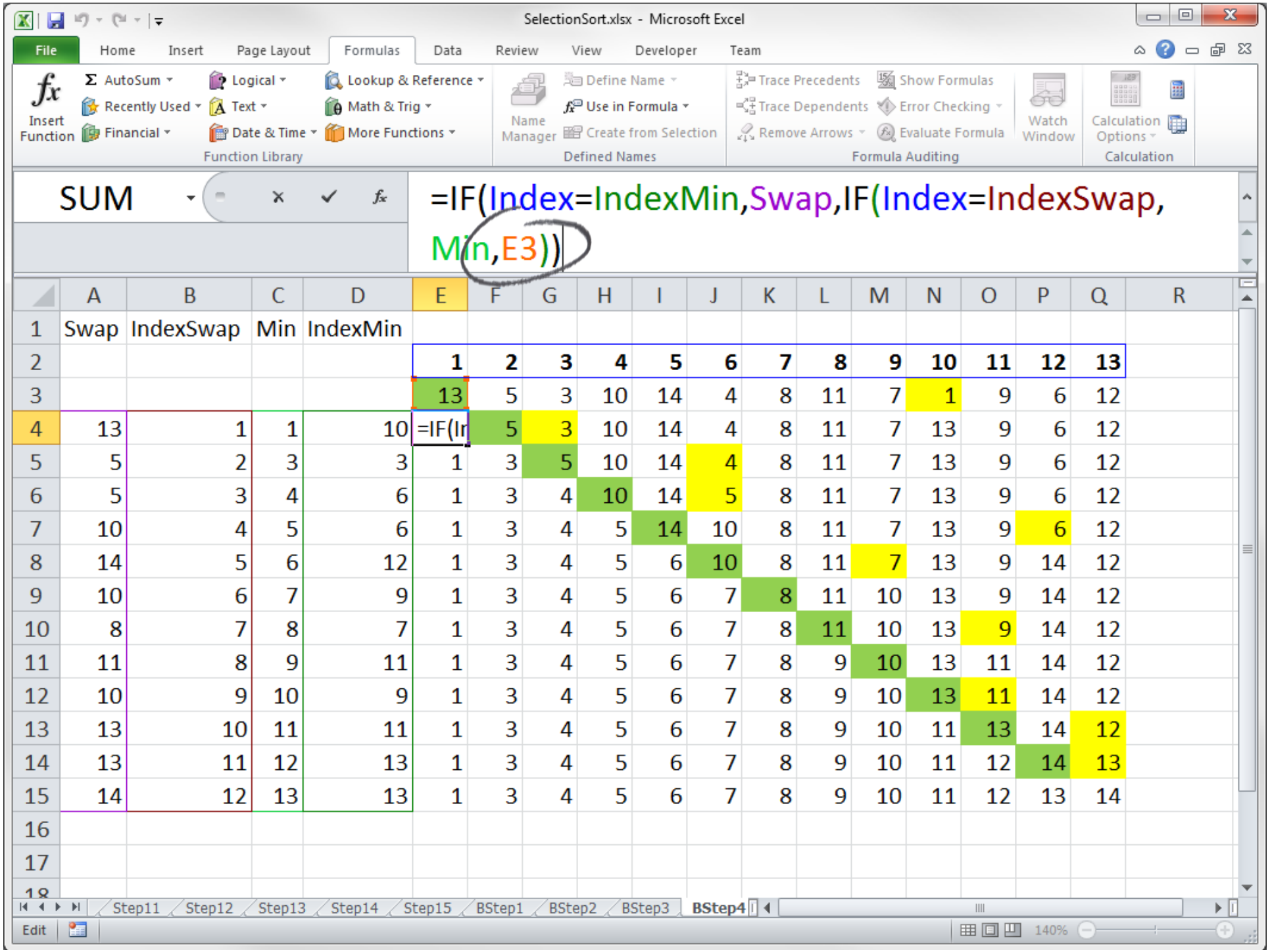
Calculation
C5
=TodaysLove
Love
Day 1 15
Day 2 15.06
Day 3 15.1202
Day 4 15.1807
Day 5 15.2414
Day 6 15.3024
Day 7 15.3636
Day 8 15.4251
Day 9 15.4868
Day 10 15.5487
Day 11 15.6109
Day 12 15.6734
Formula in a named range that depends on the cell above it
Step13
Step14
Step15
BStep1
BStep2
BStep3
BStep4
BStep5
BStep6
Ready
Average: 15.36484348
Count: 11
Sum: 169.0132783
140%



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3					13	5	3	10	14	4	8	11	7	1	9	6	12	
4	13	1	1	10	=IF(In	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	
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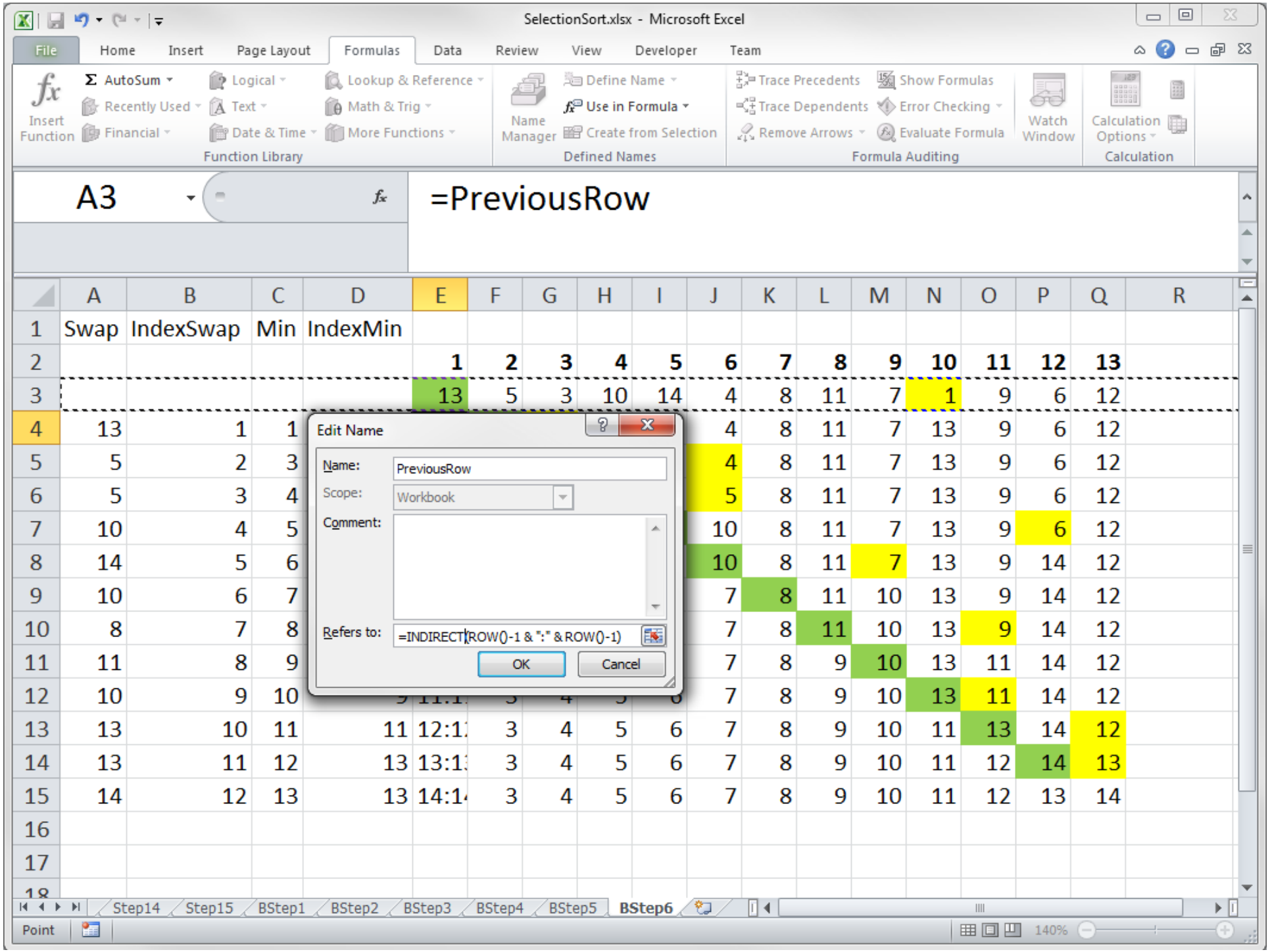
16																		
17																		



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4	13	1	1							4	8	11	7	13	9	6	12	
5	5	2	3							4	8	11	7	13	9	6	12	
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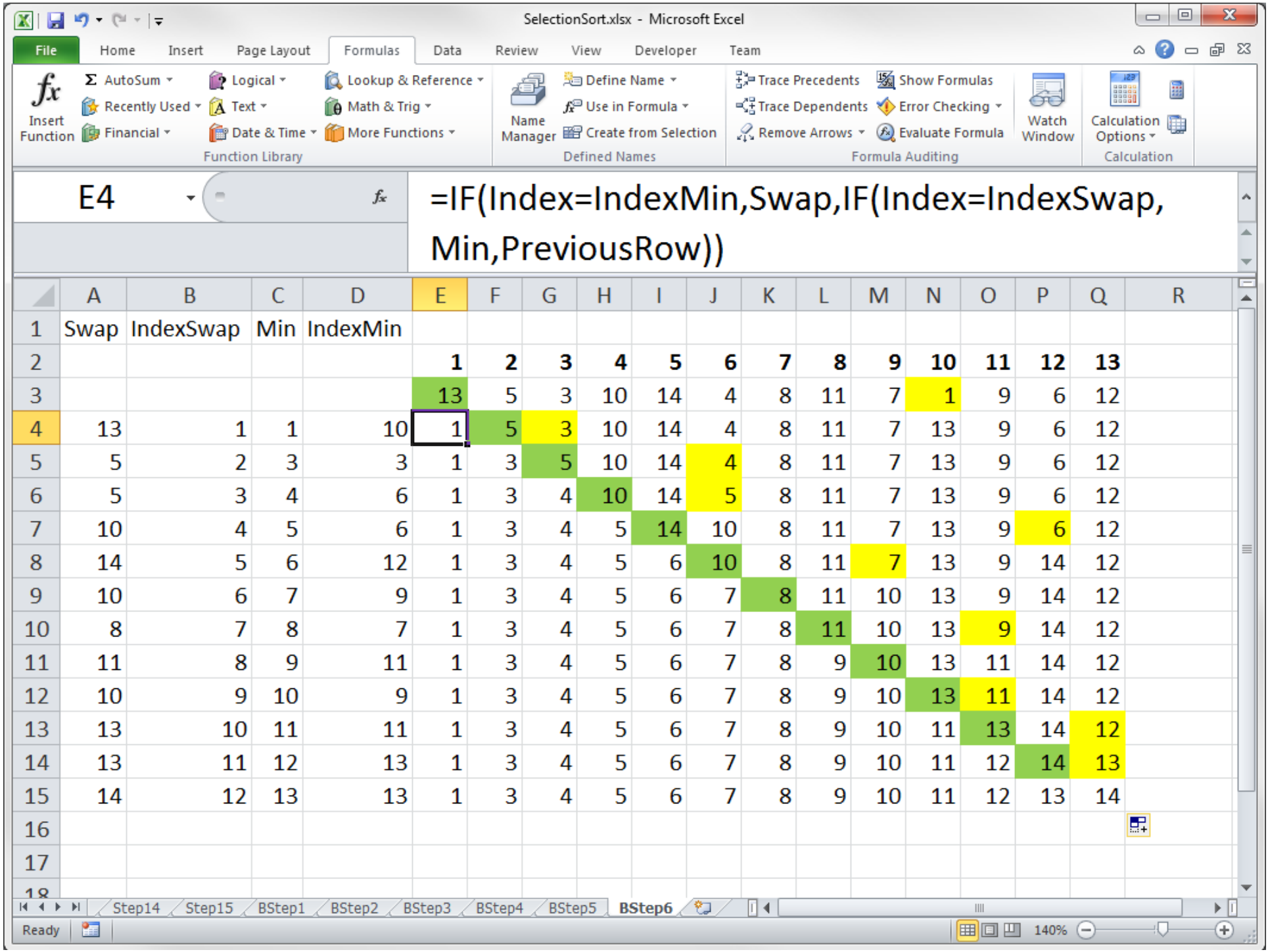
16																		
17																		



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

SelectionSort.py - C:/Users/Felienne/Dropbox/TU Delft/slides/2014/StrangeLoo...

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

```

Ln: 19 Col: 0


Me last
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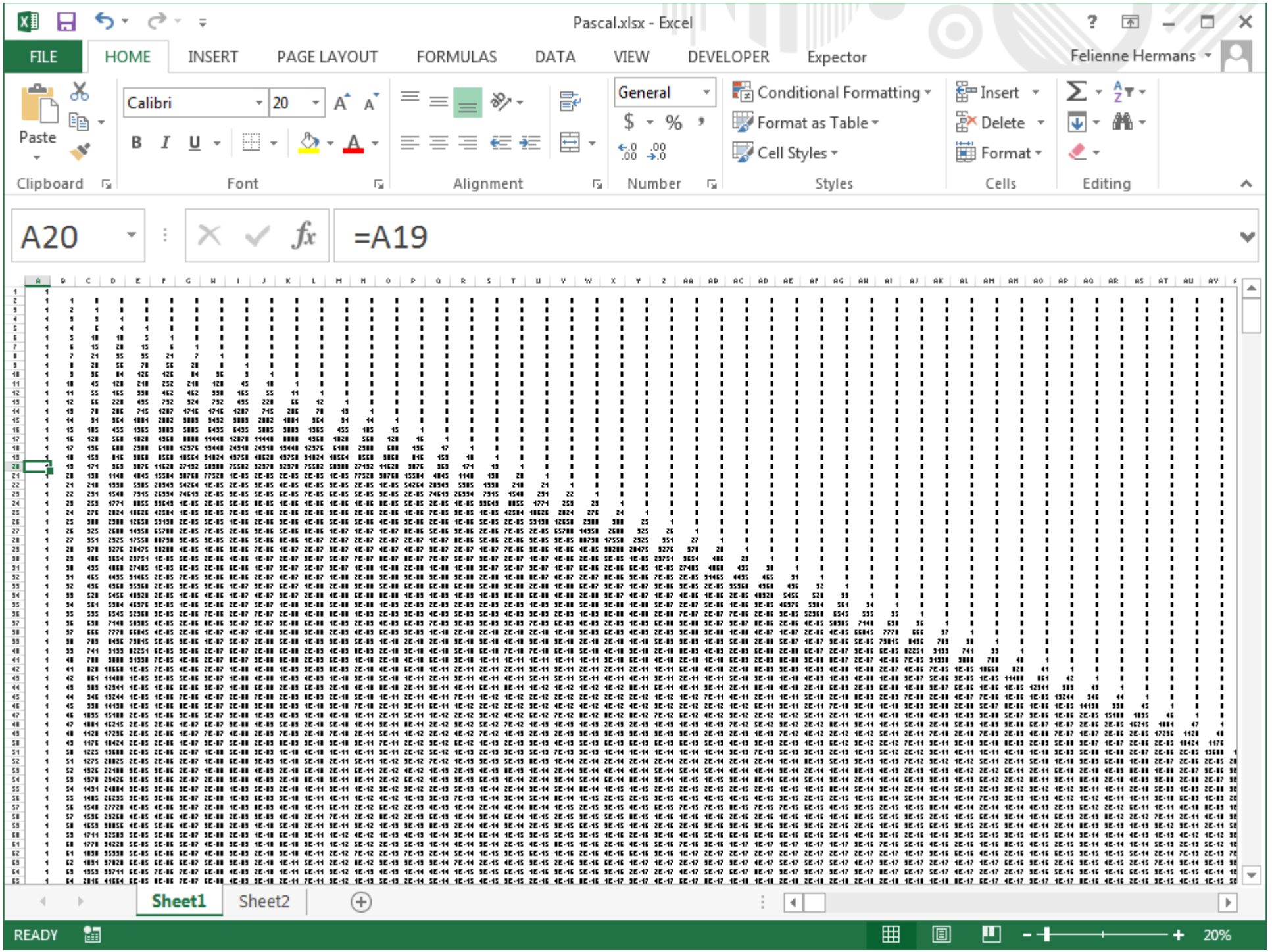
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A20
=A19
Sheet1
Sheet2
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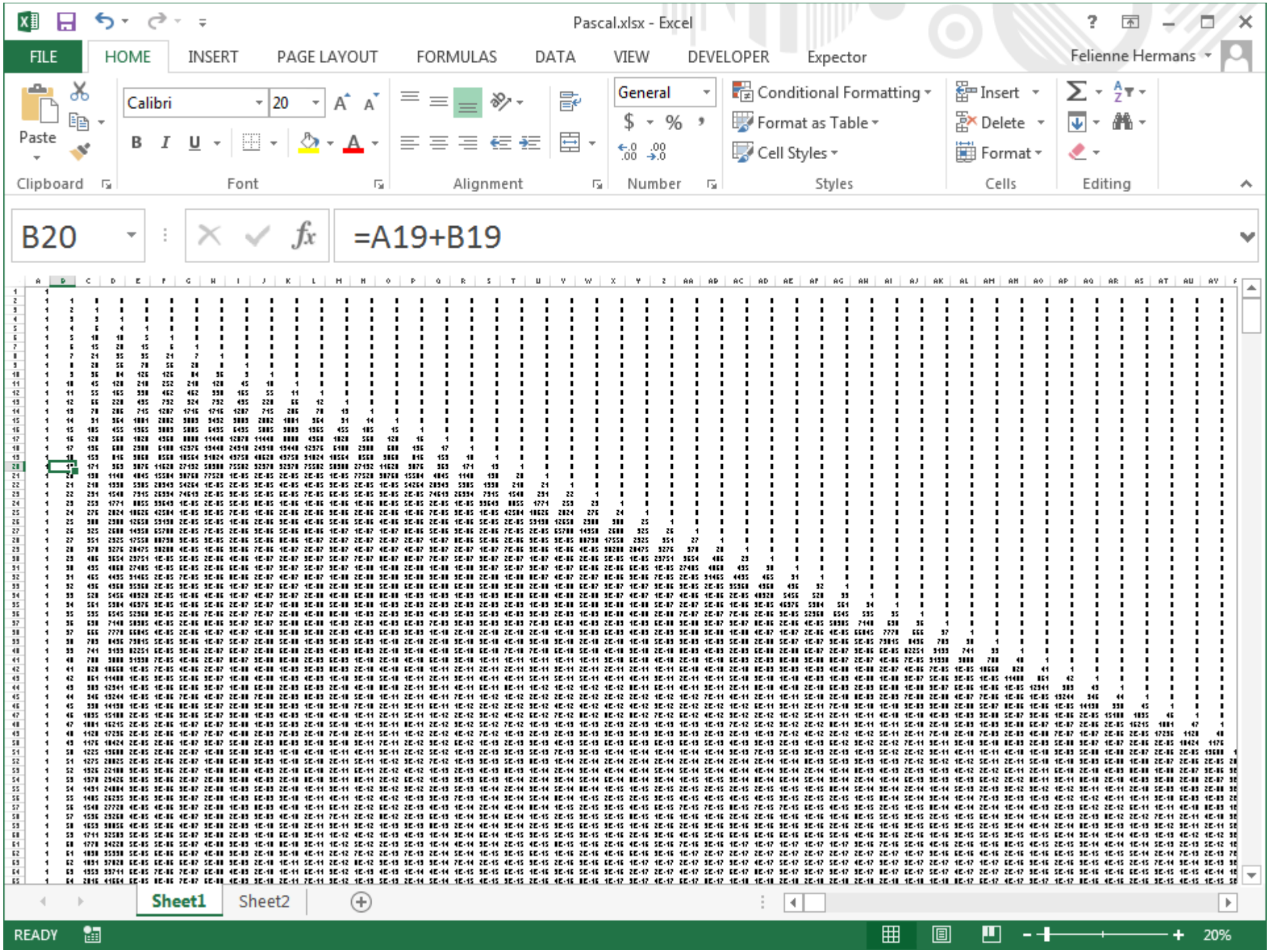
20%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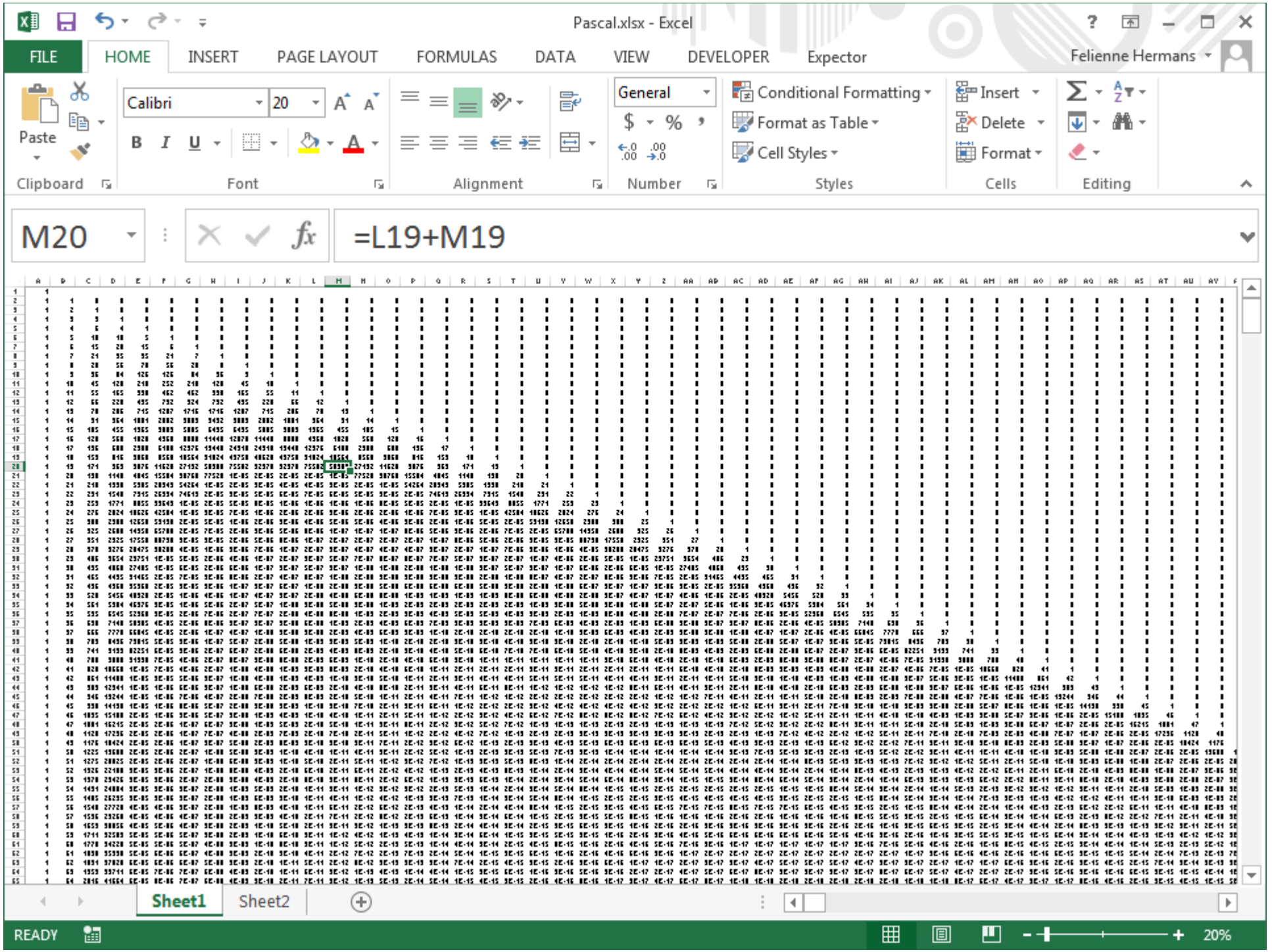
B20
=A19+B19
Sheet1
Sheet2
READY
20%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Format as Table
Cell Styles
Insert
Delete
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Clipboard
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Alignment
Number
Styles
Cells
Editing
M20
=L19+M19
Sheet1
Sheet2
READY
20%

C

Translation of: Fortran

```c
#include <stdio.h>

void pascaltriangle(unsigned int n)
{
  unsigned int c, i, j, k;

  for(i=0; i < n; i++) {
    c = 1;
    for(j=1; j <= 2*(n-1-i); j++) printf(" ");
    for(k=0; k <= i; k++) {
      printf("%3d ", c);
      c = c * (i-k)/(k+1);
    }
    printf("\n");
  }
}

int main()
{
  pascaltriangle(8);
  return 0;
}
```

C

Translation of: Fortran

```c
#include <stdio.h>

void pascaltriangle(unsigned int n)
{
  unsigned int c, i, j, k;

  for(i=0; i < n; i++) {
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      printf("%3d ", c);
      c = c * (i-k)/(k+1);
    }
    printf("\n");
  }
}

int main()
{
  pascaltriangle(8);
  return 0;
}
```
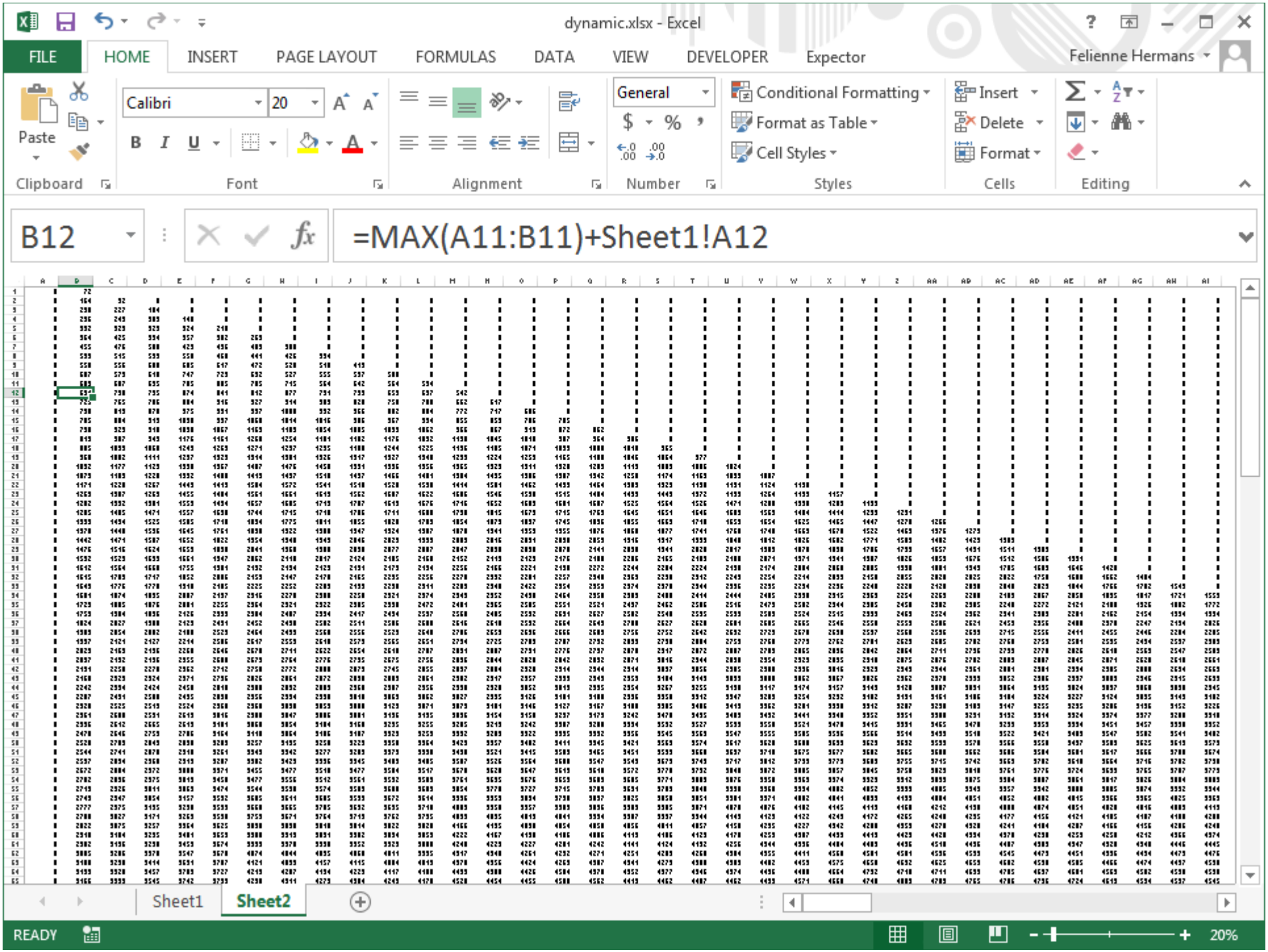

F#

```fsharp
let rec nextrow l =
    match l with
    | []      -> []
    | h :: [] -> [1]
    | h :: t  -> h + t.Head :: nextrow t

let pascalTri n = List.scan(fun l i -> 1 :: nextrow l) [1] [1 .. n]

for row in pascalTri(10) do
    for i in row do
        printf "%s" (i.ToString() + ", ")
    printfn "%s" "\n"
```


dynamic.xlsx - Excel
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Conditional Formatting
Format as Table
Cell Styles
Styles
Insert
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Cells
Editing
B12
=MAX(A11:B11)+Sheet1!A12
Sheet1
Sheet2
READY
20%

C

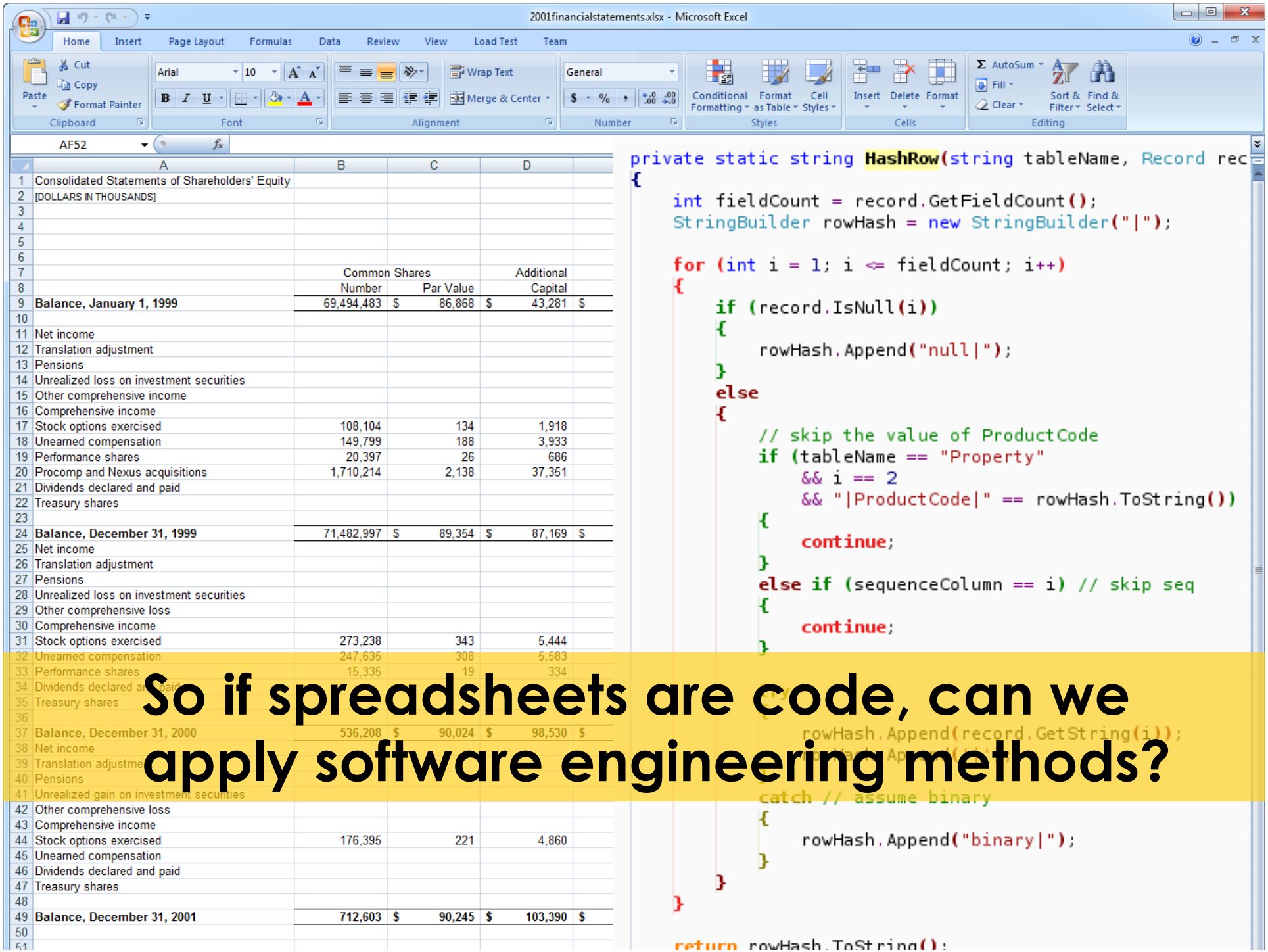
```c
#include <stdio.h>
#include <math.h>

#define max(x,y)  ((x) > (y) ? (x) : (y))

int main(void)
{
    const int len  = sizeof(tri) / sizeof(tri[0]);
    const int base = (sqrt(8*len + 1) - 1) / 2;
    int step       = base - 1;
    int stepc      = 0;

    int i;
    for (i = len - base - 1; i >= 0; --i) {
        tri[i] += max(tri[i + step], tri[i + step + 1]);
        if (++stepc == step) {
            step--;
            stepc = 0;
        }
    }

    printf("%d\n", tri[0]);
    return 0;
}
```

C

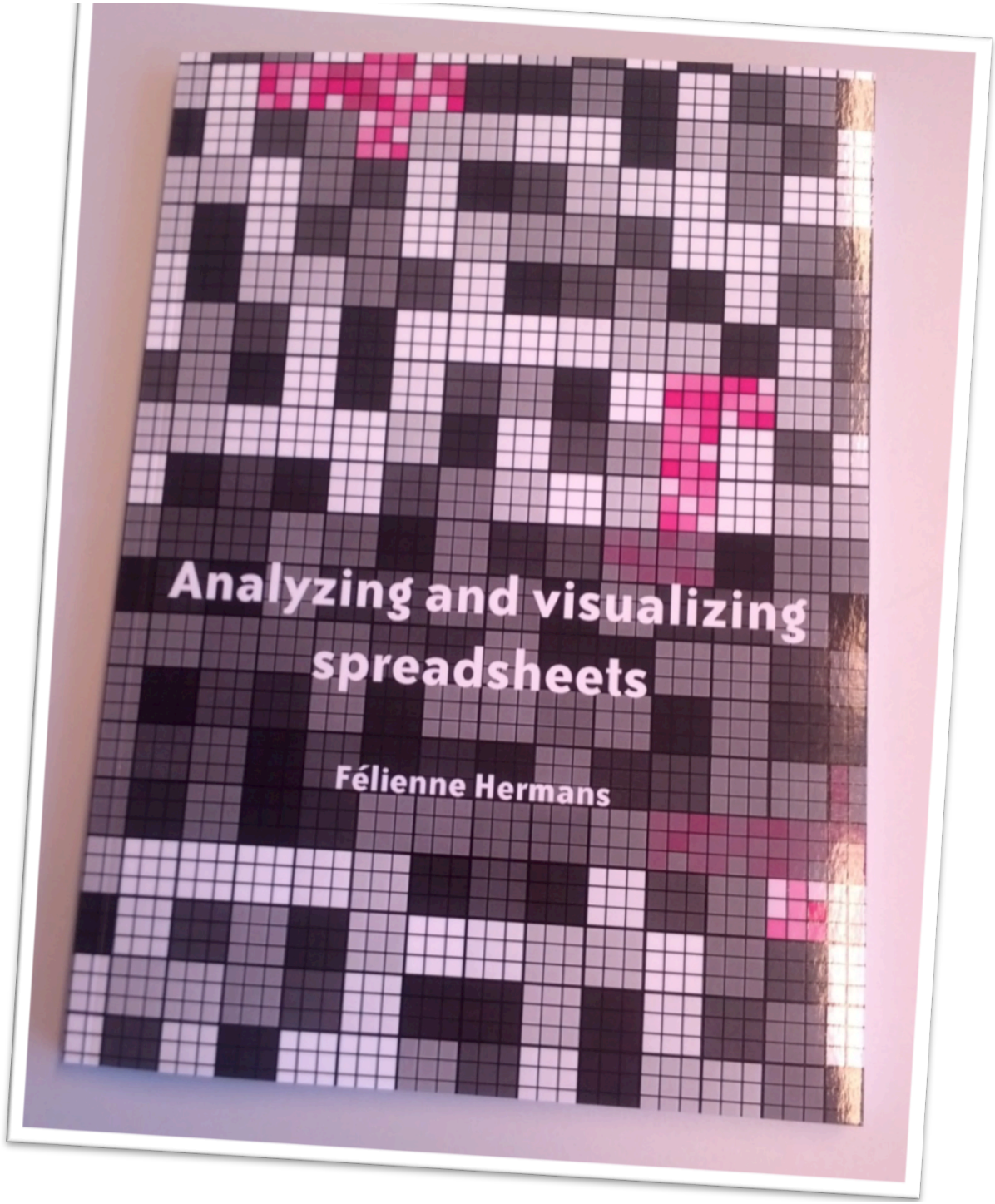
```c
#include <stdio.h>
#include <math.h>

#define max(x,y)  ((x) > (y) ? (x) : (y))

int main(void)
{
    const int len  = sizeof(tri) / sizeof(tri[0]);
    const int base = (sqrt(8*len + 1) - 1) / 2;
    int step       = base - 1;
    int stepc      = 0;

    int i;
    for (i = len - base - 1; i >= 0; --i) {
        tri[i] += max(tri[i + step], tri[i + step + 1]);
        if (++stepc == step) {
            step--;
            stepc = 0;
        }
    }

    printf("%d\n", tri[0]);
    return 0;
}
```

Haskell

```haskell
parse = map (map read . words) . lines
f x y z = x + max y z
g xs ys = zipWith3 f xs ys $ tail ys
solve = head . foldr1 g
main = readFile "triangle.txt" >>= print . solve . parse
```

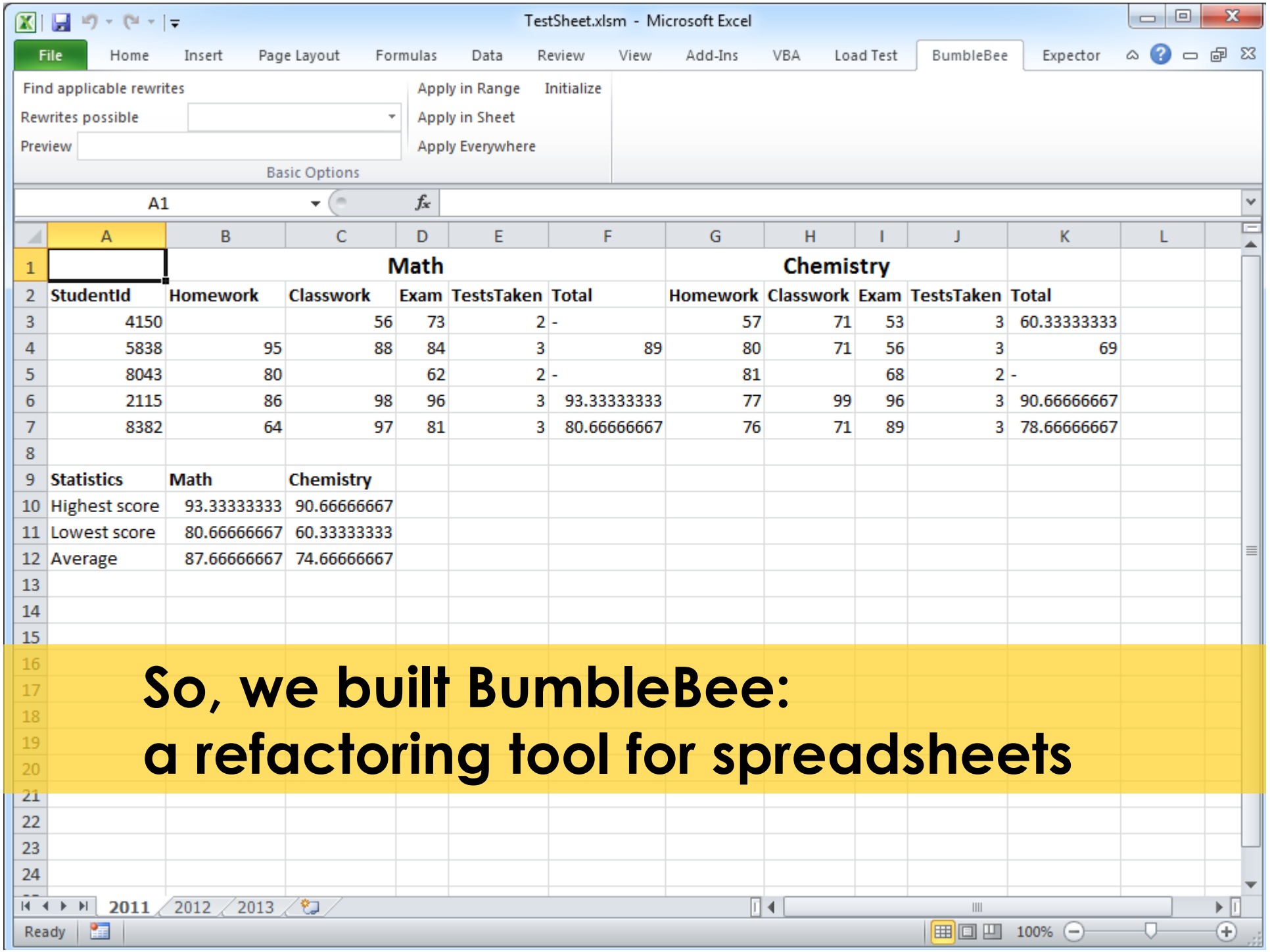


So if spreadsheets are code, can we apply software engineering methods?

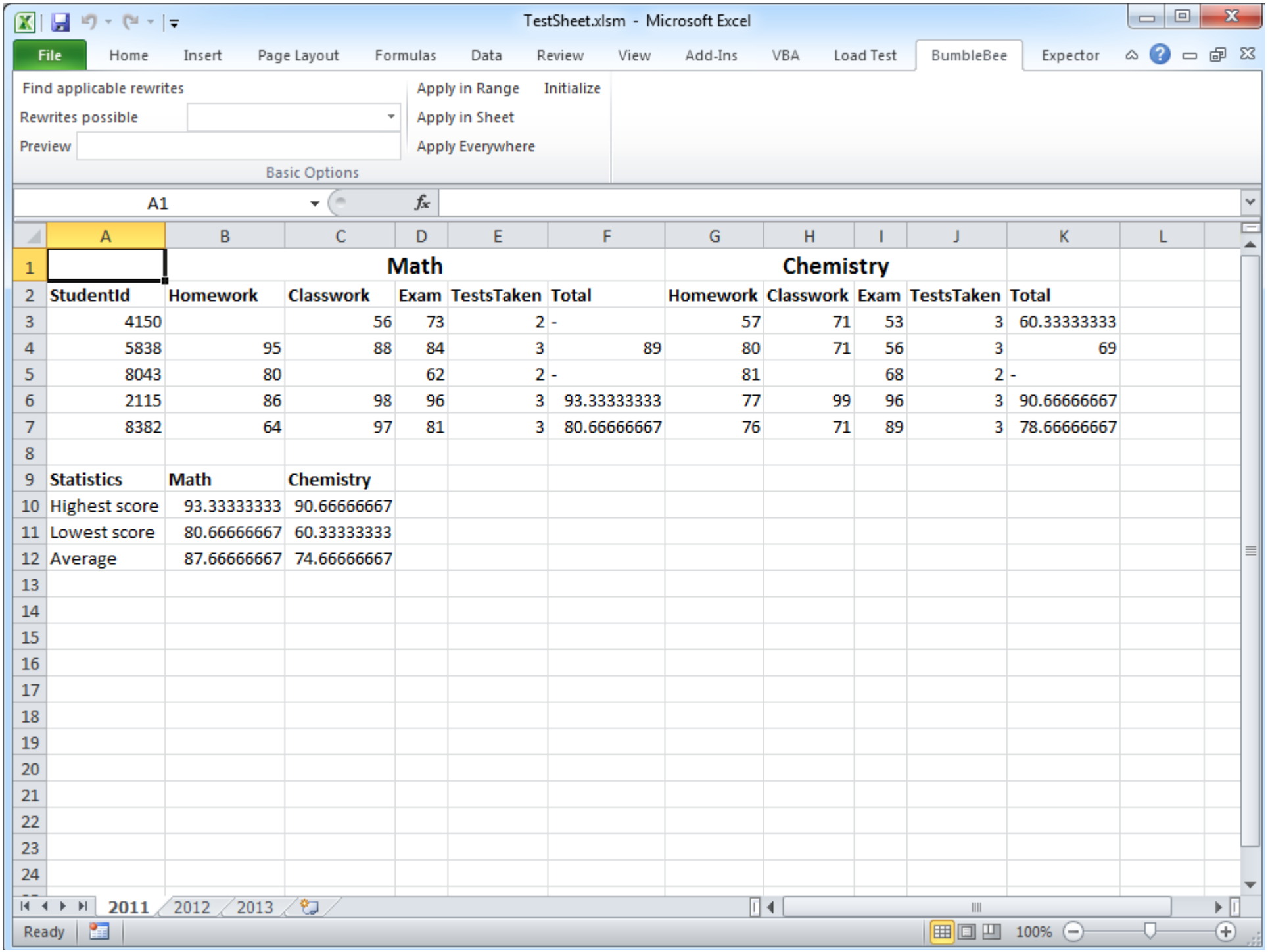

Analyzing and visualizing spreadsheets
Félienne Hermans


YES WE
CAN.


So, we built BumbleBee:
a refactoring tool for spreadsheets



So, we built BumbleBee:
a refactoring tool for spreadsheets


TestSheet.xlsm - Microsoft Excel
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Add-Ins
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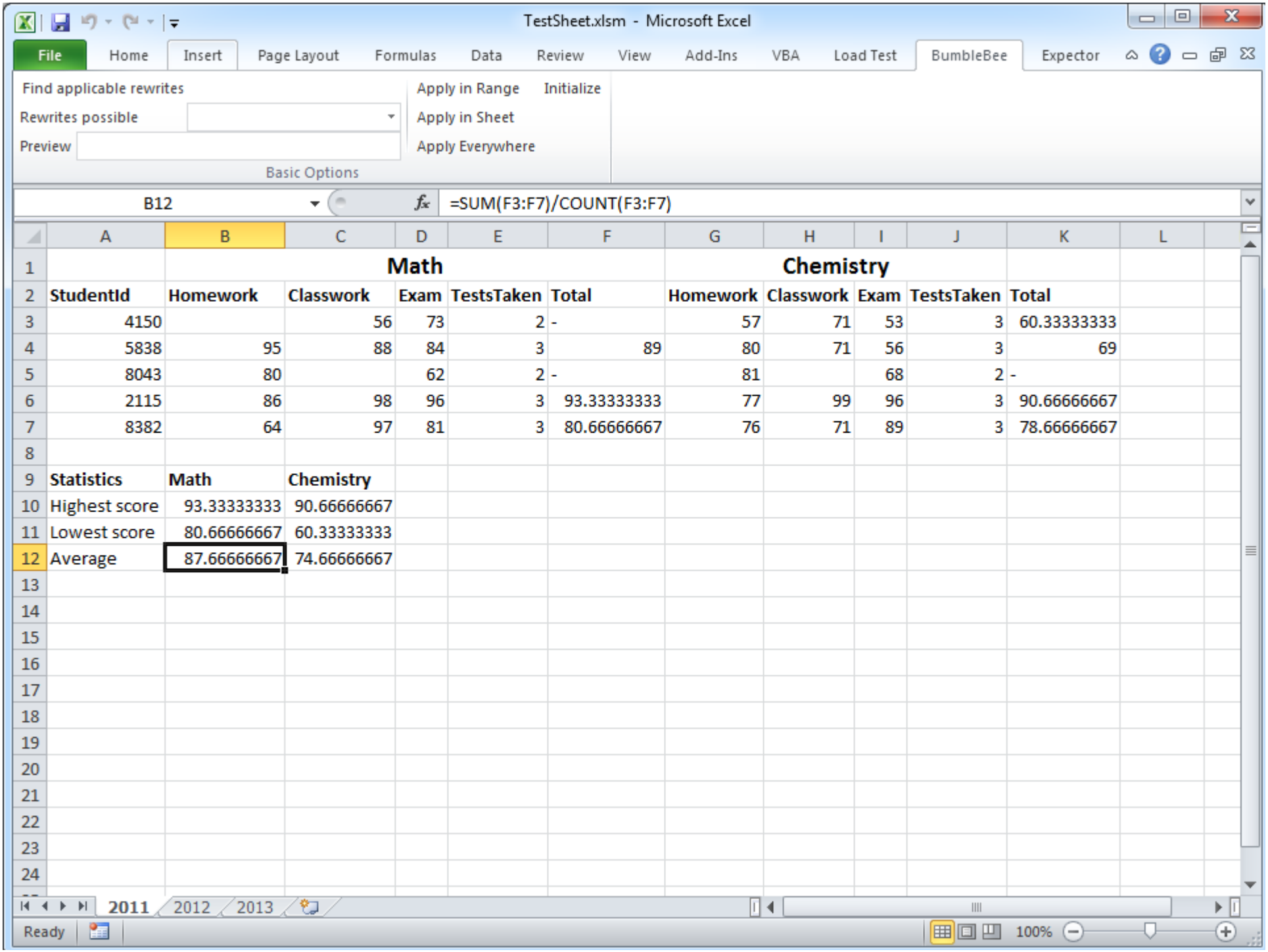
Expector
Find applicable rewrites
Rewrites possible
Preview
Basic Options
Apply in Range
Initialize
Apply in Sheet
Apply Everywhere
A1
Math
Chemistry
StudentId
Homework
Classwork
Exam
TestsTaken
Total
4150 56 73 2 - 57 71 53 3 60.33333333
5838 95 88 84 3 89 80 71 56 3 69
8043 80 62 2 - 81 68 2 -
2115 86 98 96 3 93.33333333 77 99 96 3 90.66666667
8382 64 97 81 3 80.66666667 76 71 89 3 78.66666667
Statistics
Math
Chemistry
Highest score 93.33333333 90.66666667
Lowest score 80.66666667 60.33333333
Average 87.66666667 74.66666667
2011
2012
2013
Ready
100%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Apply in Sheet
Apply Everywhere
B12
=SUM(F3:F7)/COUNT(F3:F7)
Math
Chemistry
StudentId
Homework
Classwork
Exam
TestsTaken
Total
4150 56 73 2 - 57 71 53 3 60.33333333
5838 95 88 84 3 89 80 71 56 3 69
8043 80 62 2 - 81 68 2 -
2115 86 98 96 3 93.33333333 77 99 96 3 90.66666667
8382 64 97 81 3 80.66666667 76 71 89 3 78.66666667
Statistics
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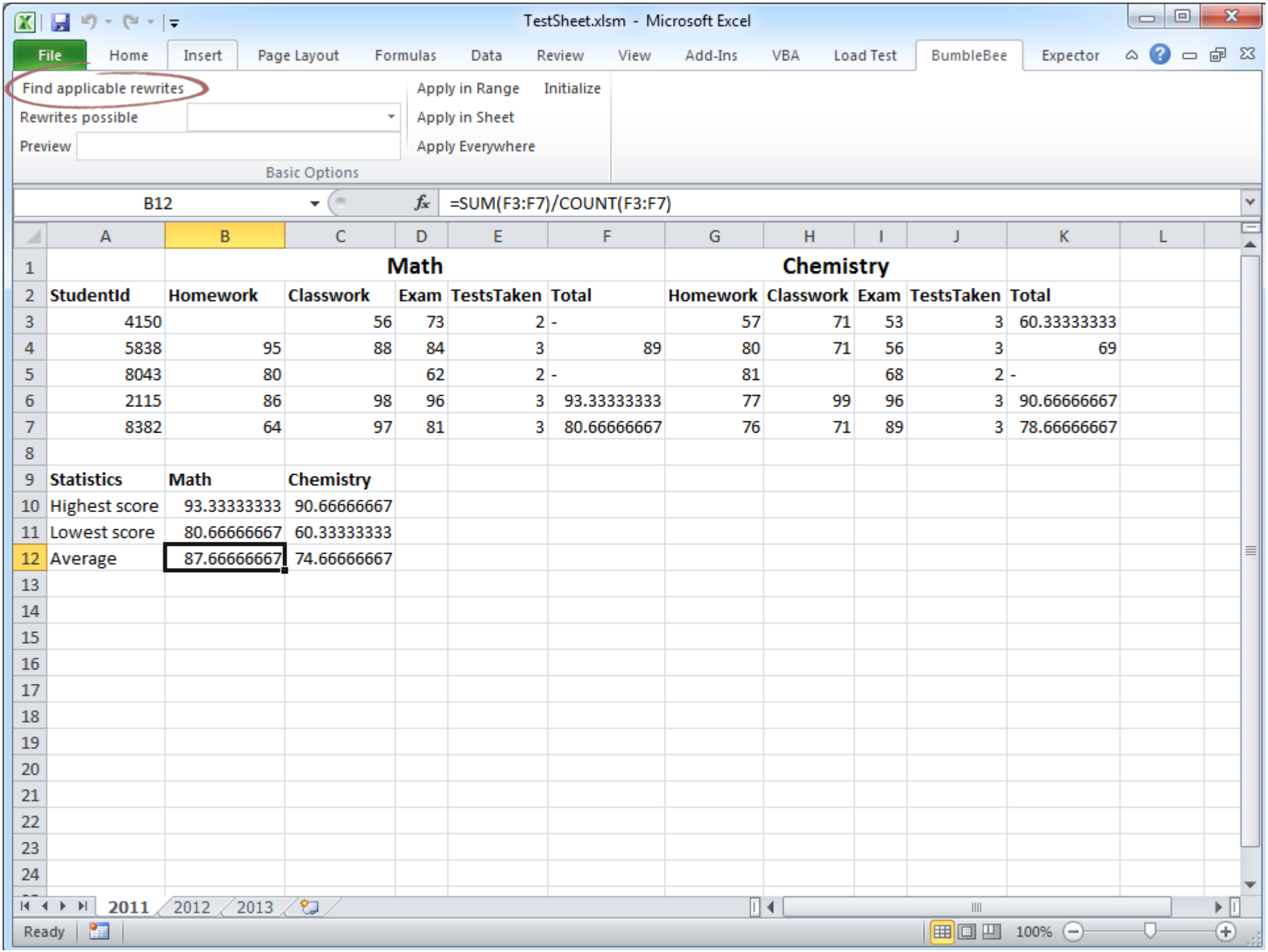

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1			Math					Chemistry				
2	StudentId	Homework	Classwork	Exam	TestsTaken	Total	Homework	Classwork	Exam	TestsTaken	Total	
3	4150		56	73	2	-	57	71	53	3	60.33333333	
4	5838	95	88	84	3	89	80	71	56	3	69	
5	8043	80		62	2	-	81		68	2	-	
6	2115	86	98	96	3	93.33333333	77	99	96	3	90.66666667	
7	8382	64	97	81	3	80.66666667	76	71	89	3	78.66666667	
8												
9	Statistics	Math	Chemistry									
10	Highest score	93.33333333	90.66666667									
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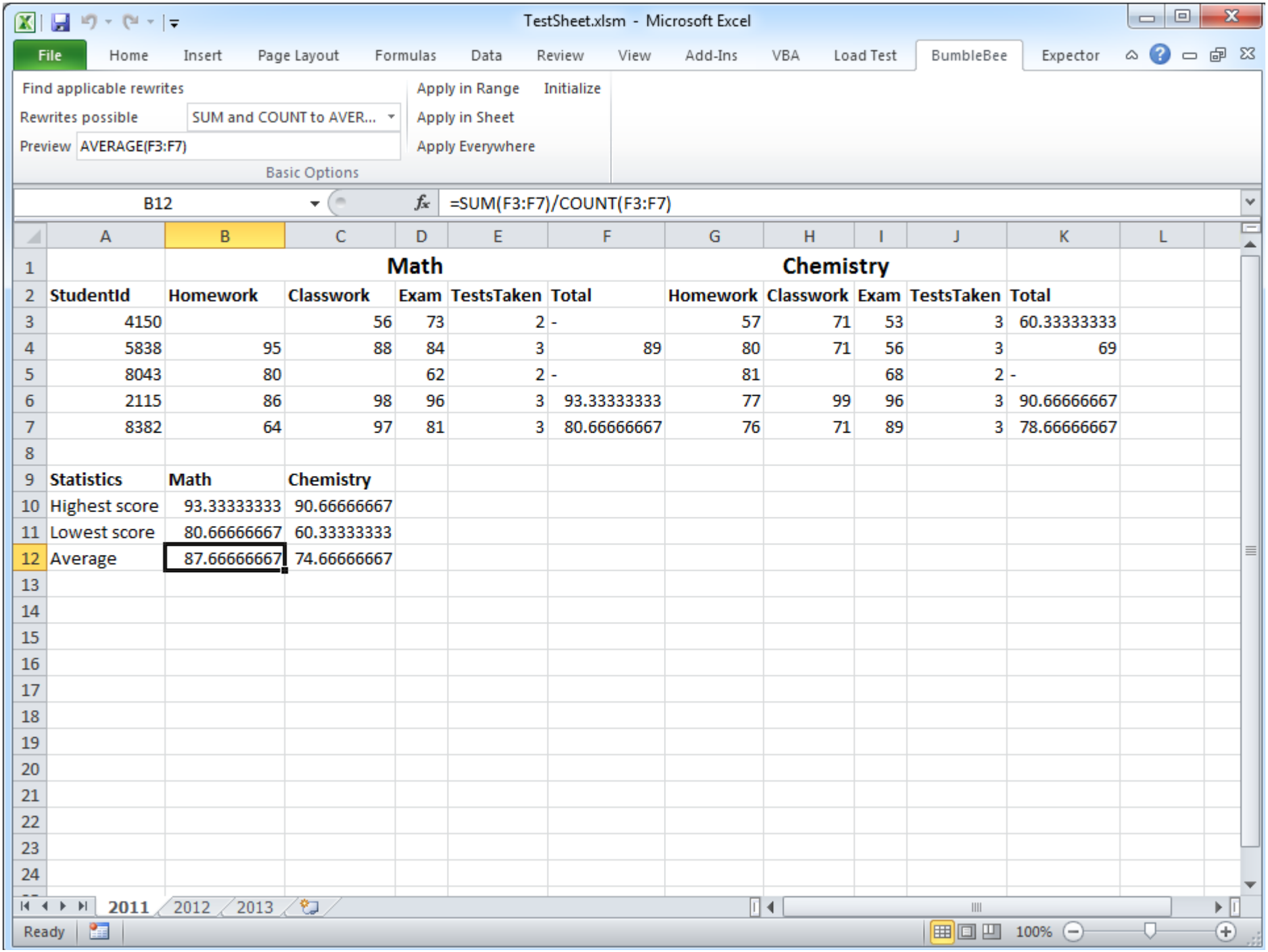

	A	B	C	D	E	F	G	H	I	J	K	L
1			Math					Chemistry				
2	StudentId	Homework	Classwork	Exam	TestsTaken	Total	Homework	Classwork	Exam	TestsTaken	Total	
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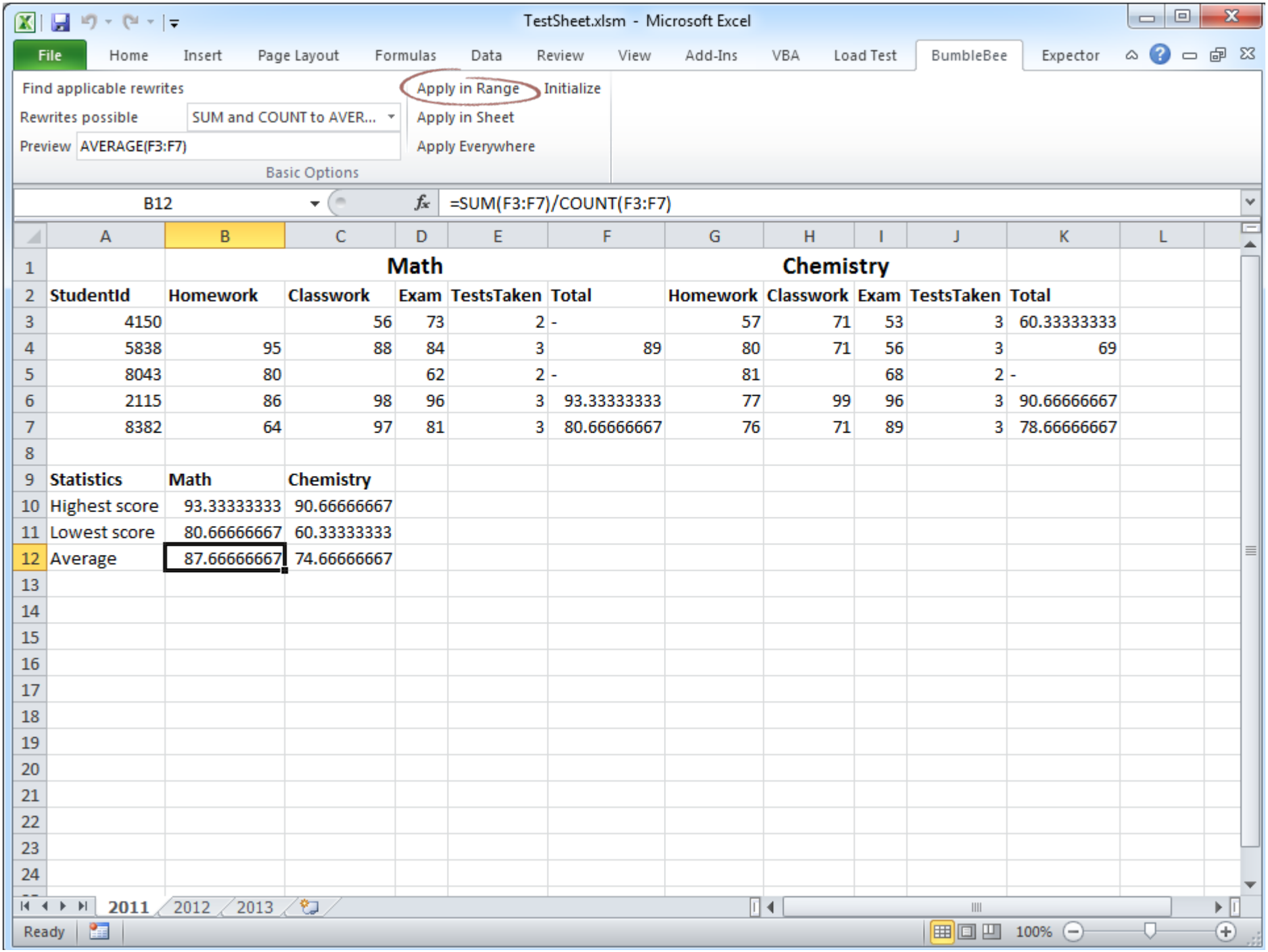
TestSheet.xlsm - Microsoft Excel
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Expector
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Apply in Sheet
Apply Everywhere
B12
=SUM(F3:F7)/COUNT(F3:F7)
Math
Chemistry
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Classwork
Exam
TestsTaken
Total
4150
5838
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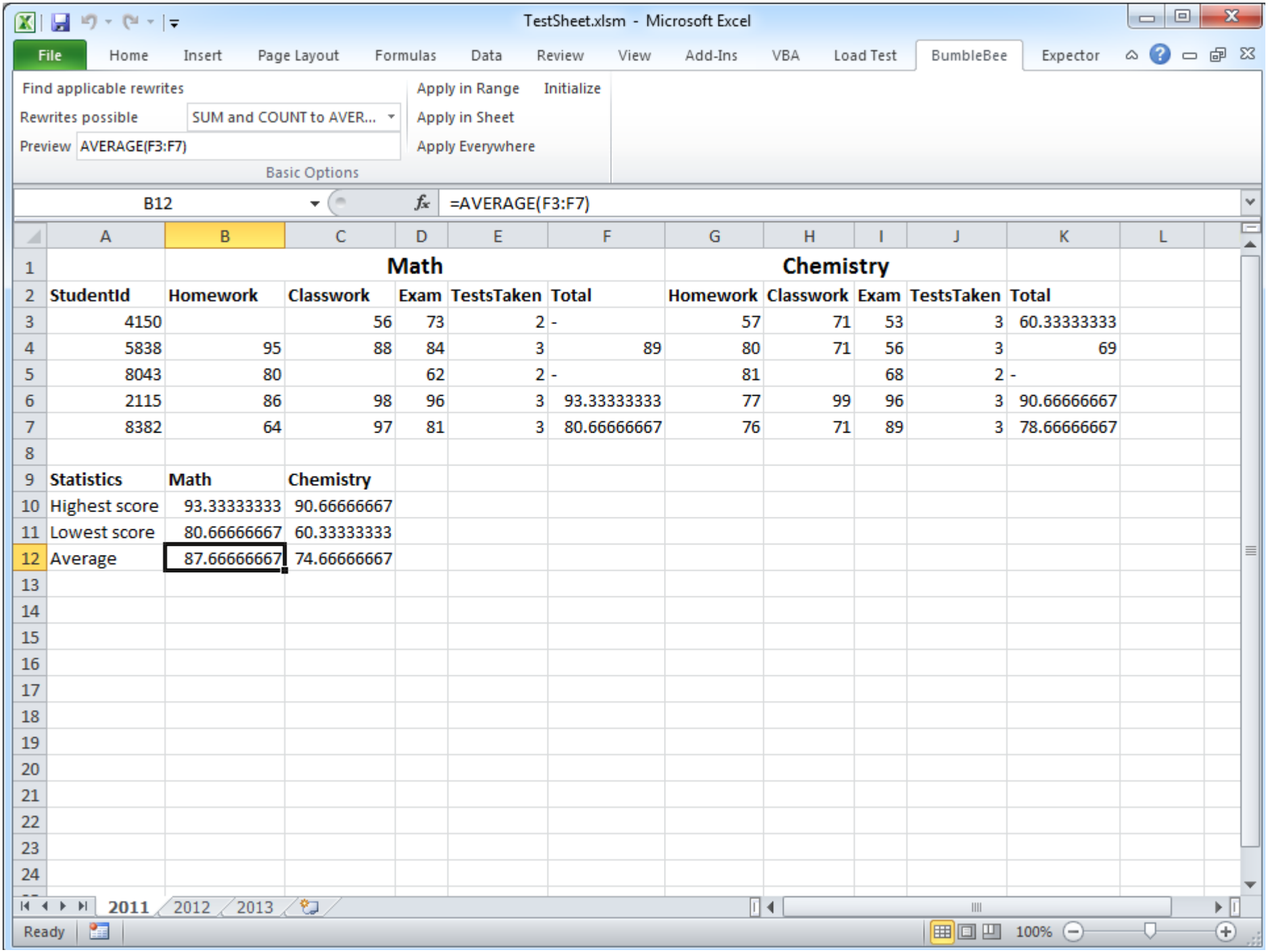

		Math					Chemistry				
StudentId	Homework	Classwork	Exam	TestsTaken	Total	Homework	Classwork	Exam	TestsTaken	Total
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Statistics	Math	Chemistry
Highest score	93.33333333	90.66666667
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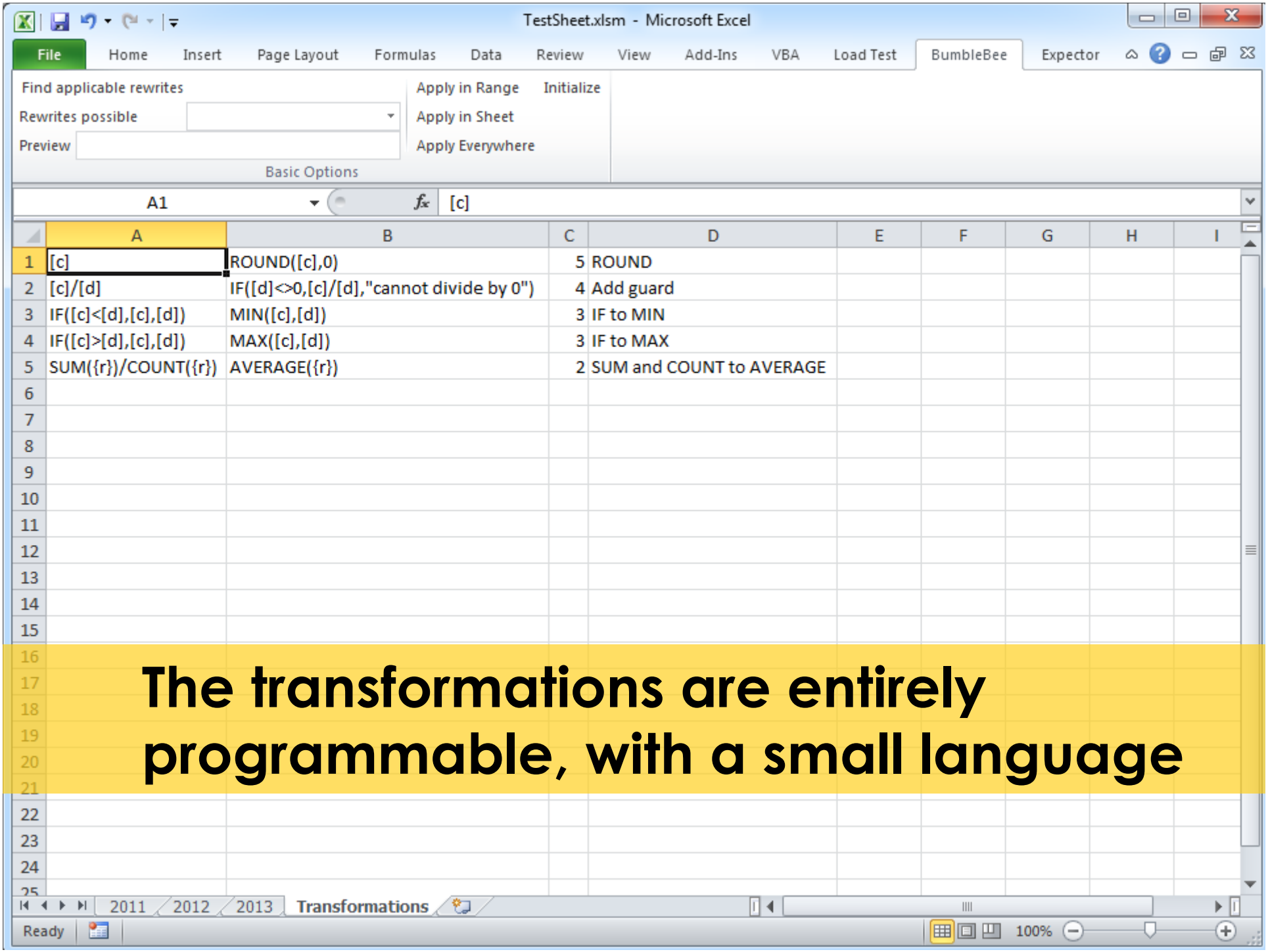
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Find applicable rewrites
Rewrites possible
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Basic Options
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Initialize
Apply in Sheet
Apply Everywhere
A1
[c]
[c] ROUND([c],0) 5 ROUND
[c]/[d] IF([d]<>0,[c]/[d],"cannot divide by 0") 4 Add guard
IF([c]<[d],[c],[d]) MIN([c],[d]) 3 IF to MIN
IF([c]>[d],[c],[d]) MAX([c],[d]) 3 IF to MAX
SUM({r})/COUNT({r}) AVERAGE({r}) 2 SUM and COUNT to AVERAGE
The transformations are entirely programmable, with a small language
2011
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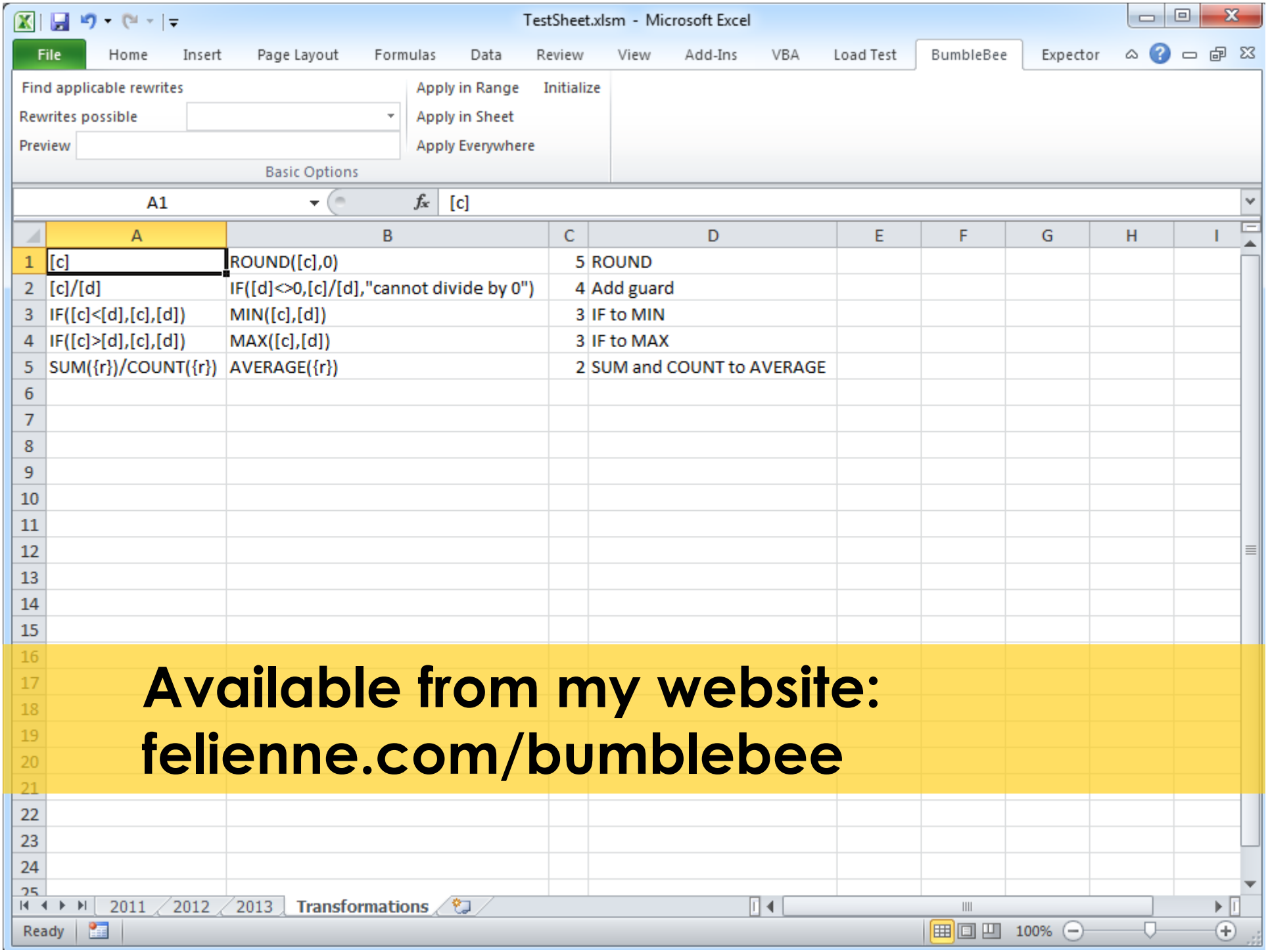
2013
Transformations
Ready
100%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Apply Everywhere
A1
[c]
[c] ROUND([c],0) 5 ROUND
[c]/[d] IF([d]<>0,[c]/[d],"cannot divide by 0") 4 Add guard
IF([c]<[d],[c],[d]) MIN([c],[d]) 3 IF to MIN
IF([c]>[d],[c],[d]) MAX([c],[d]) 3 IF to MAX
SUM({r})/COUNT({r}) AVERAGE({r}) 2 SUM and COUNT to AVERAGE
Available from my website:
felienne.com/bumblebee
2011
2012
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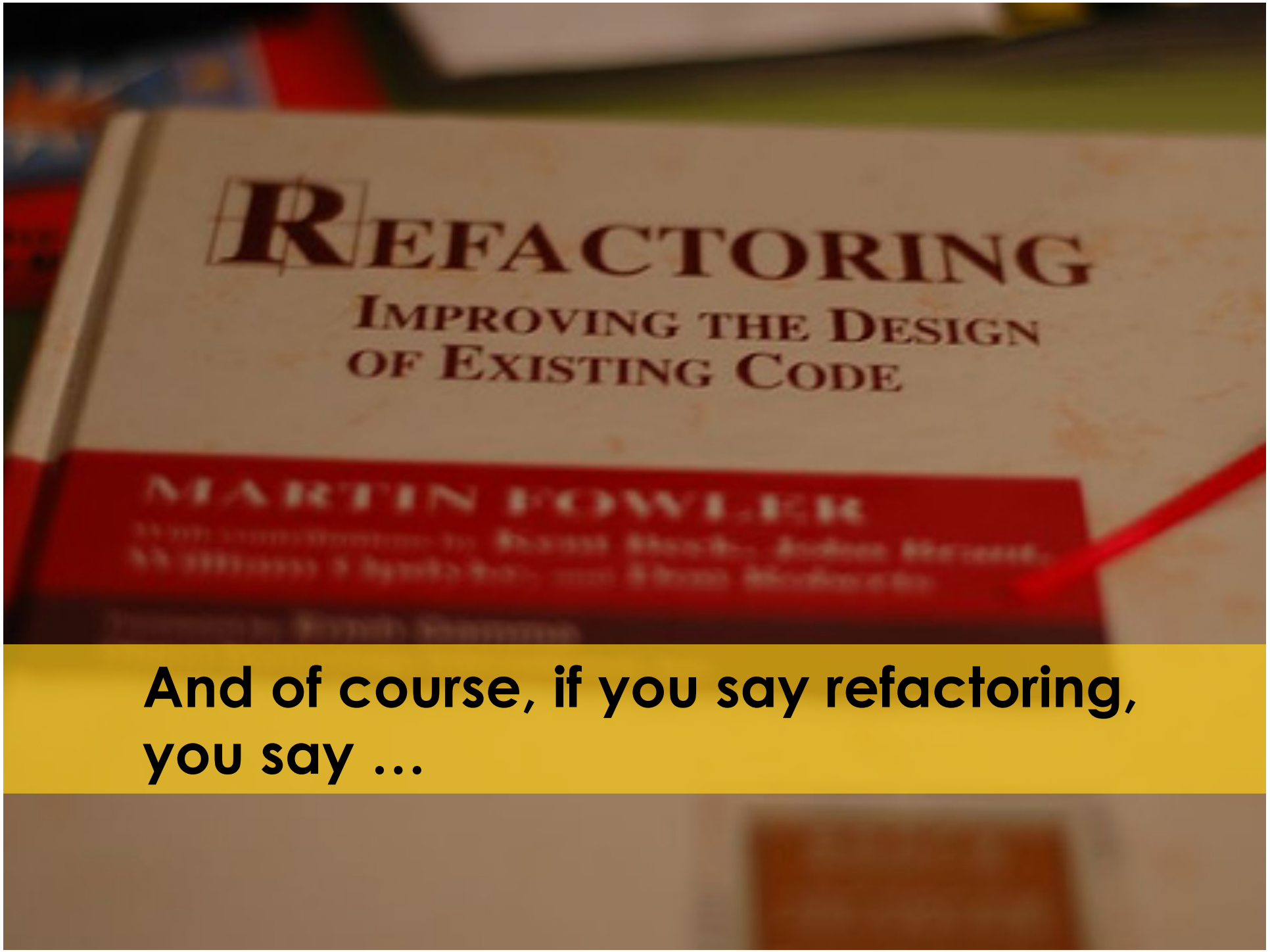
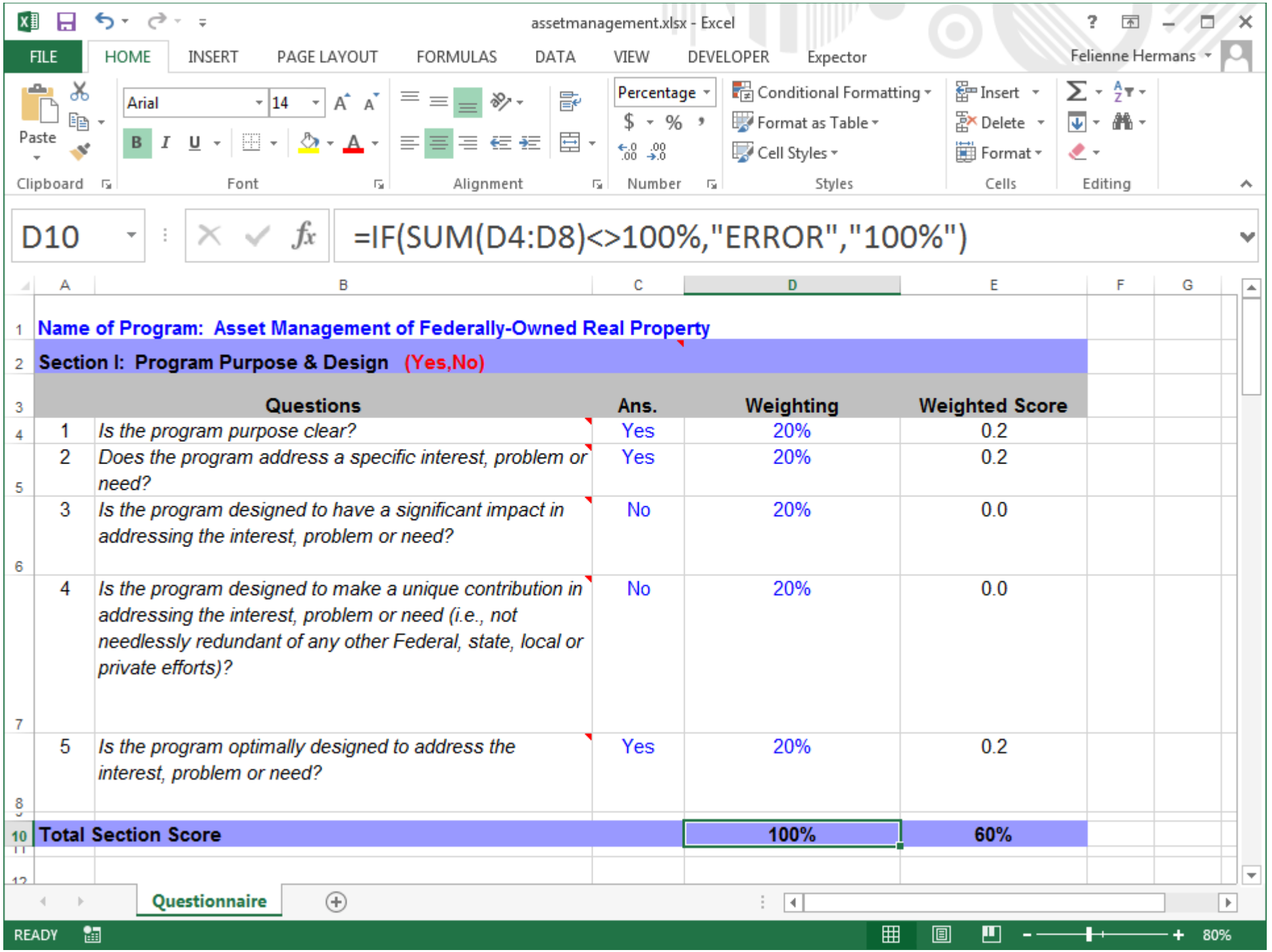
Transformations
Ready
100%



And of course, if you say refactoring, you say …


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


assetmanagement.xlsx - Excel
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Felienne Hermans
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Conditional Formatting
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Cell Styles
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Styles
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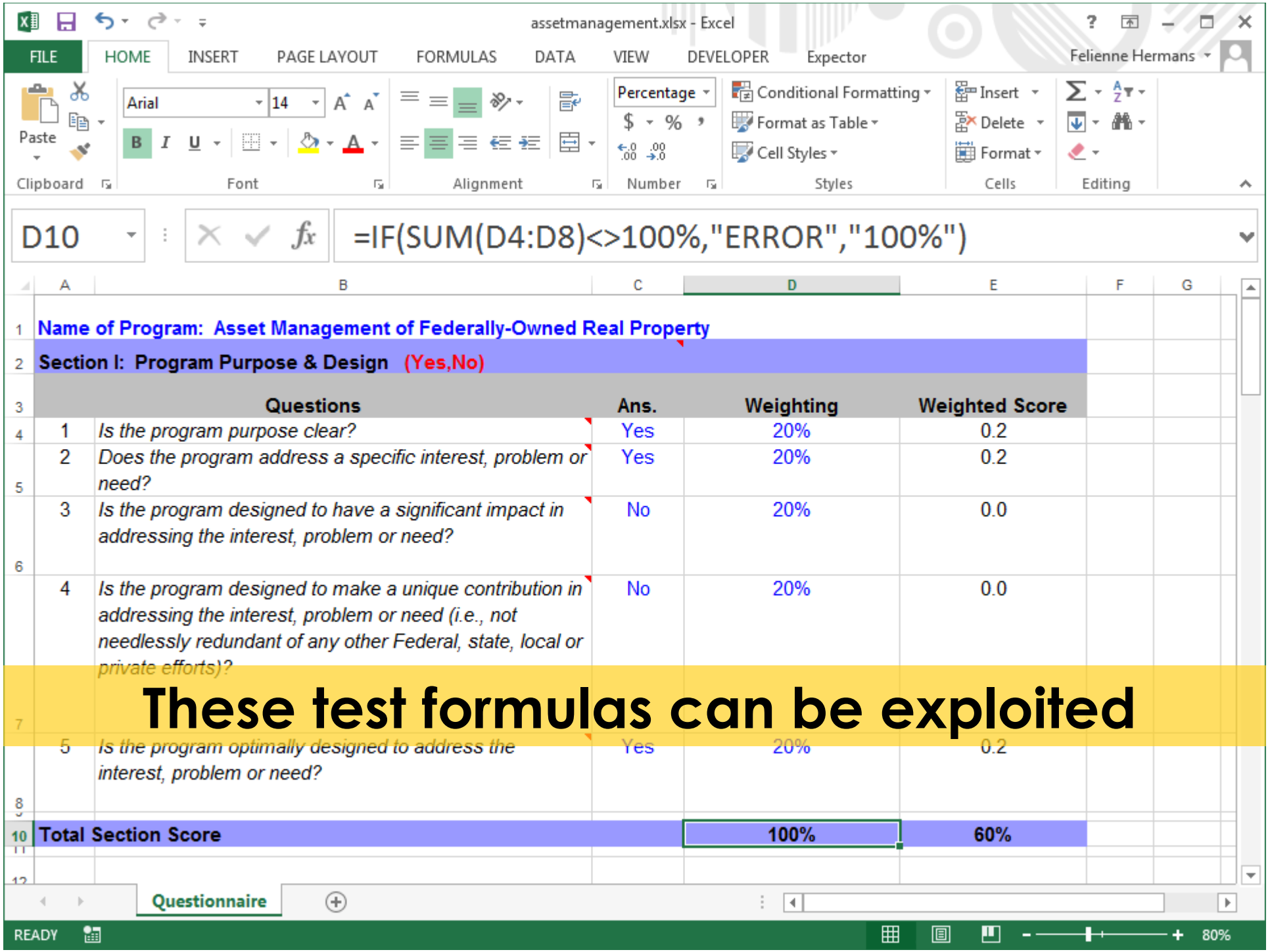
Editing
D10
=IF(SUM(D4:D8)<>100%,"ERROR","100%")
Name of Program: Asset Management of Federally-Owned Real Property
Section I: Program Purpose & Design (Yes,No)
Questions
Ans.
Weighting
Weighted Score
1 Is the program purpose clear? Yes 20% 0.2
2 Does the program address a specific interest, problem or need? Yes 20% 0.2
3 Is the program designed to have a significant impact in addressing the interest, problem or need? No 20% 0.0
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
5 Is the program optimally designed to address the interest, problem or need? Yes 20% 0.2
Total Section Score 100% 60%
Questionnaire
READY
80%


assetmanagement.xlsx - Excel
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Felienne Hermans
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=IF(SUM(D4:D8)<>100%,"ERROR","100%")
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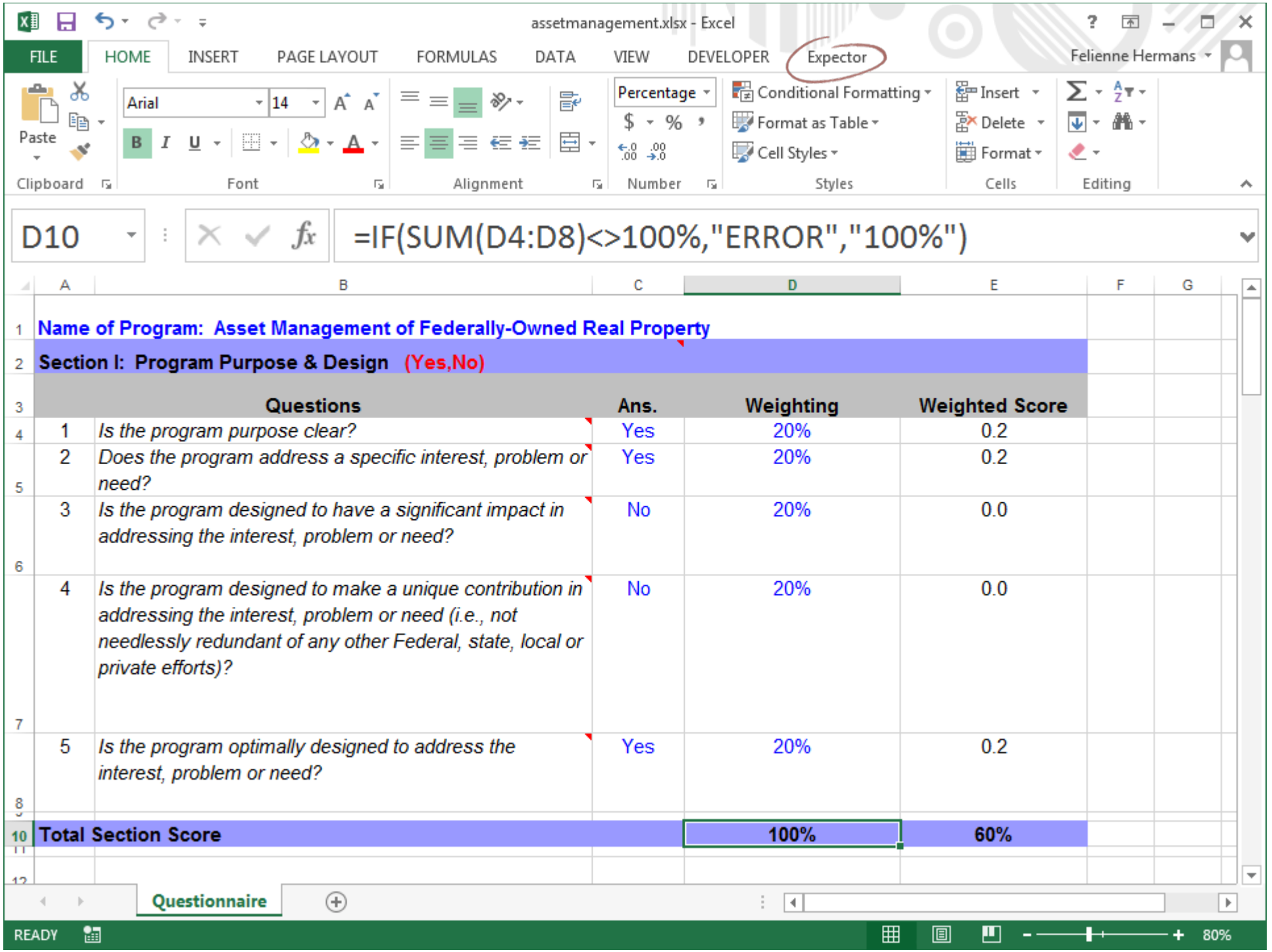
3 Is the program designed to have a significant impact in addressing the interest, problem or need? No 20% 0.0
4 Is the program designed to make a unique contribution in addressing the interest, problem or need (i.e., not needlessly redundant of any other Federal, state, local or private efforts)? No 20% 0.0
These test formulas can be exploited
5 Is the program optimally designed to address the interest, problem or need? Yes 20% 0.2
Total Section Score 100% 60%
Questionnaire
READY
80%


assetmanagement.xlsx - Excel
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D10
=IF(SUM(D4:D8)<>100%,"ERROR","100%")
Name of Program: Asset Management of Federally-Owned Real Property
Section I: Program Purpose & Design (Yes,No)
Questions
Ans.
Weighting
Weighted Score
1 Is the program purpose clear? Yes 20% 0.2
2 Does the program address a specific interest, problem or need? Yes 20% 0.2
3 Is the program designed to have a significant impact in addressing the interest, problem or need? No 20% 0.0
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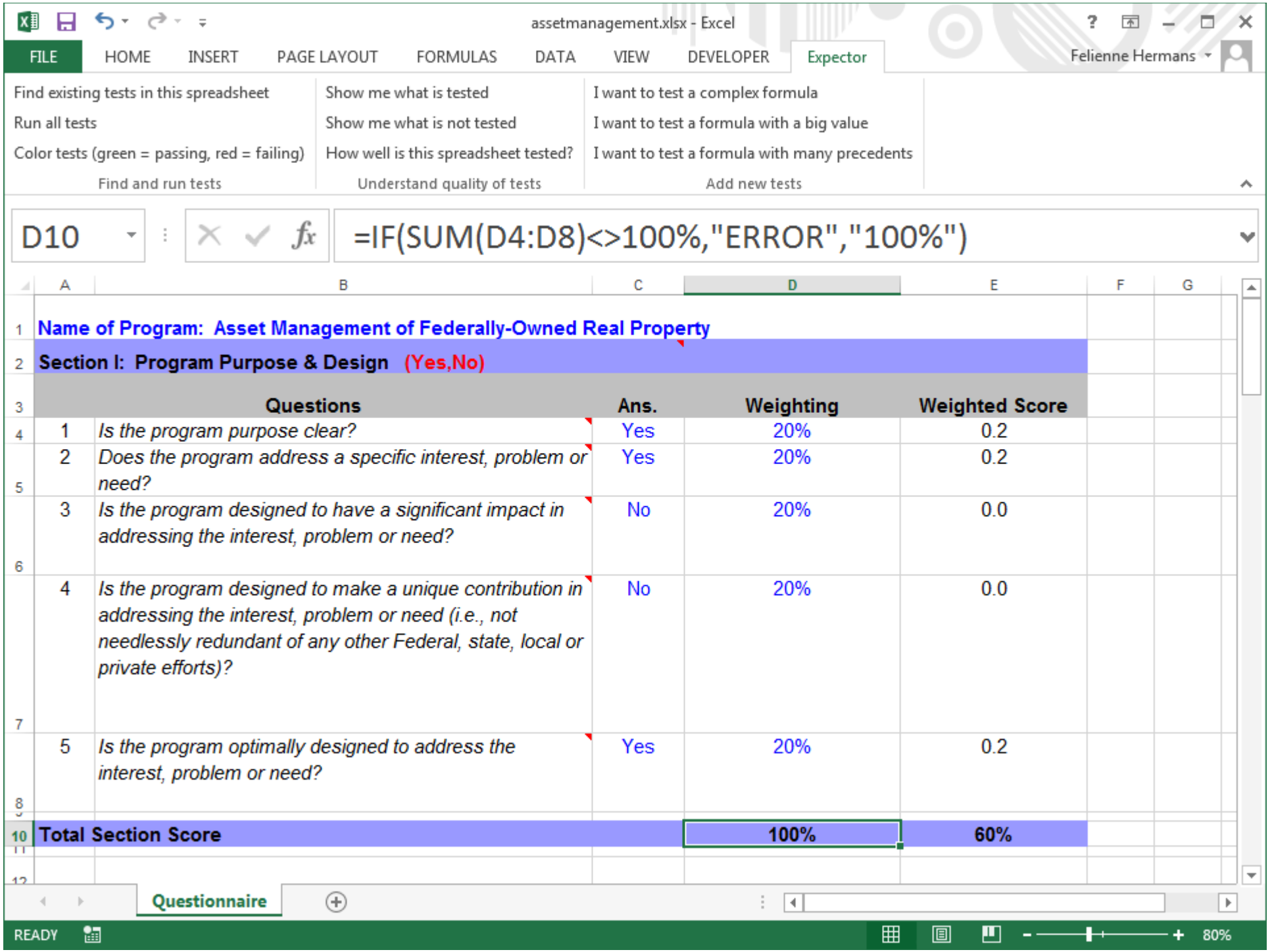
5 Is the program optimally designed to address the interest, problem or need? Yes 20% 0.2
Total Section Score 100% 60%
Questionnaire
READY
80%


assetmanagement.xlsx - Excel
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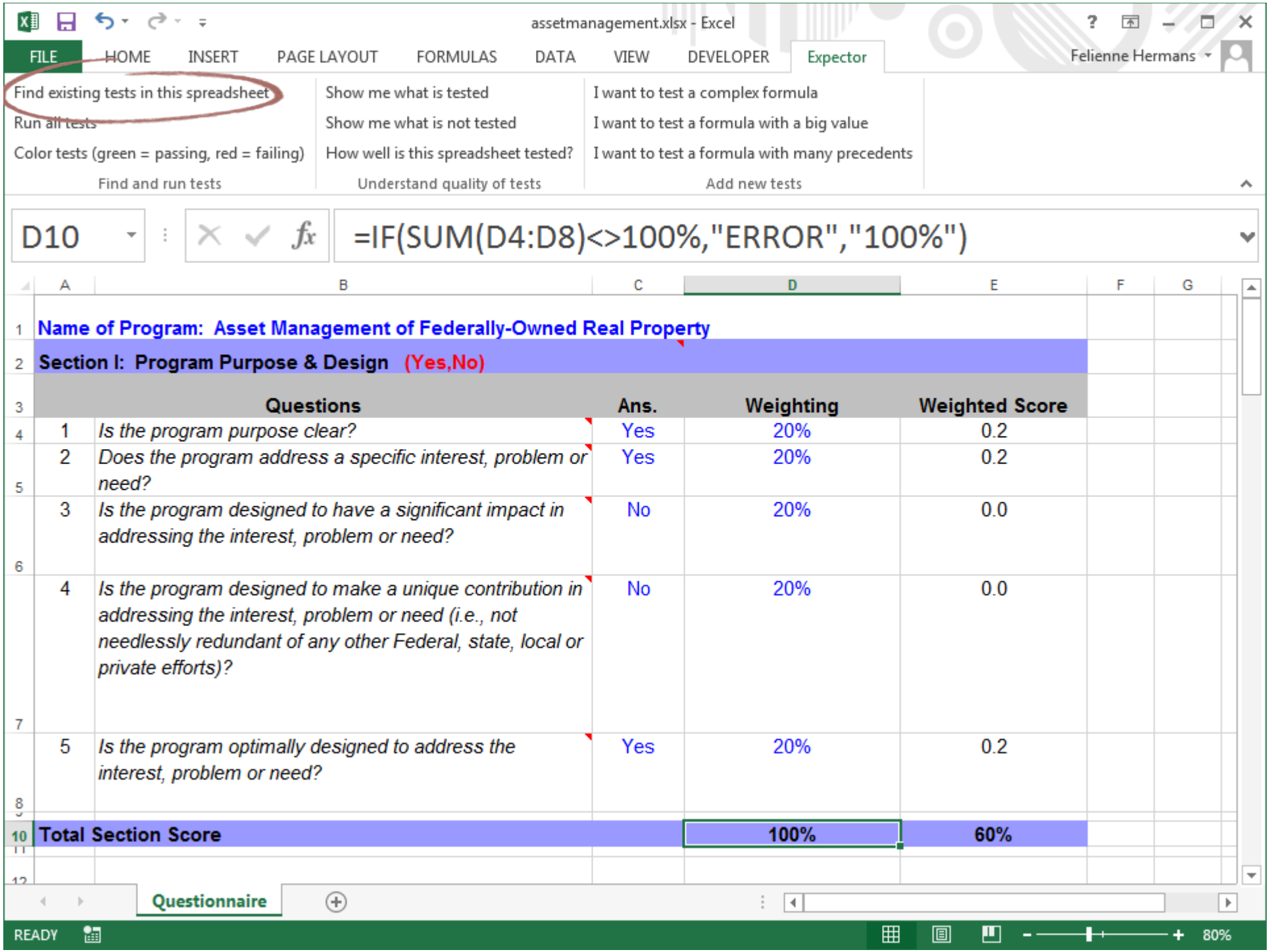
Expector
Felienne Hermans
Find existing tests in this spreadsheet
Run all tests
Color tests (green = passing, red = failing)
Find and run tests
Show me what is tested
Show me what is not tested
How well is this spreadsheet tested?
Understand quality of tests
I want to test a complex formula
I want to test a formula with a big value
I want to test a formula with many precedents
Add new tests
D10
=IF(SUM(D4:D8)<>100%,"ERROR","100%")
Name of Program: Asset Management of Federally-Owned Real Property
Section I: Program Purpose & Design (Yes,No)
Questions
Ans.
Weighting
Weighted Score
1 Is the program purpose clear? Yes 20% 0.2
2 Does the program address a specific interest, problem or need? Yes 20% 0.2
3 Is the program designed to have a significant impact in addressing the interest, problem or need? No 20% 0.0
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
5 Is the program optimally designed to address the interest, problem or need? Yes 20% 0.2
Total Section Score 100% 60%
Questionnaire
READY
80%


assetmanagement.xlsx - Excel
FILE
HOME
INSERT
PAGE LAYOUT
FORMULAS
DATA
VIEW
DEVELOPER
Expector
Felienne Hermans
Find existing tests in this spreadsheet
Run all tests
Color tests (green = passing, red = failing)
Find and run tests
Show me what is tested
Show me what is not tested
How well is this spreadsheet tested?
Understand quality of tests
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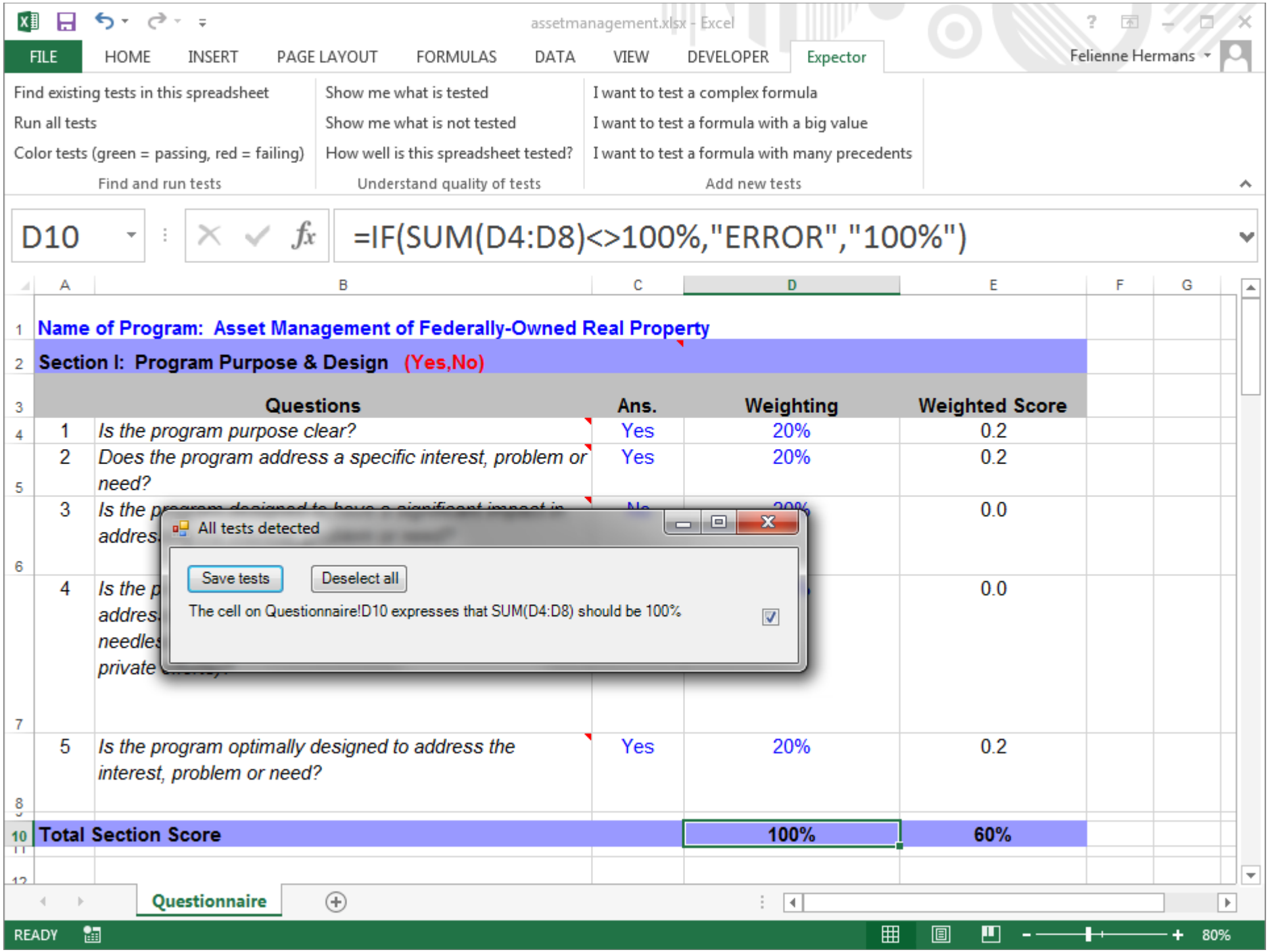
Questions
Ans.
Weighting
Weighted Score
1 Is the program purpose clear? Yes 20% 0.2
2 Does the program address a specific interest, problem or need? Yes 20% 0.2
3 Is the program designed to have a significant impact in addressing the interest, problem or need? No 20% 0.0
4 Is the program designed to 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
5 Is the program optimally designed to address the interest, problem or need? Yes 20% 0.2
Total Section Score 100% 60%
Questionnaire
READY
80%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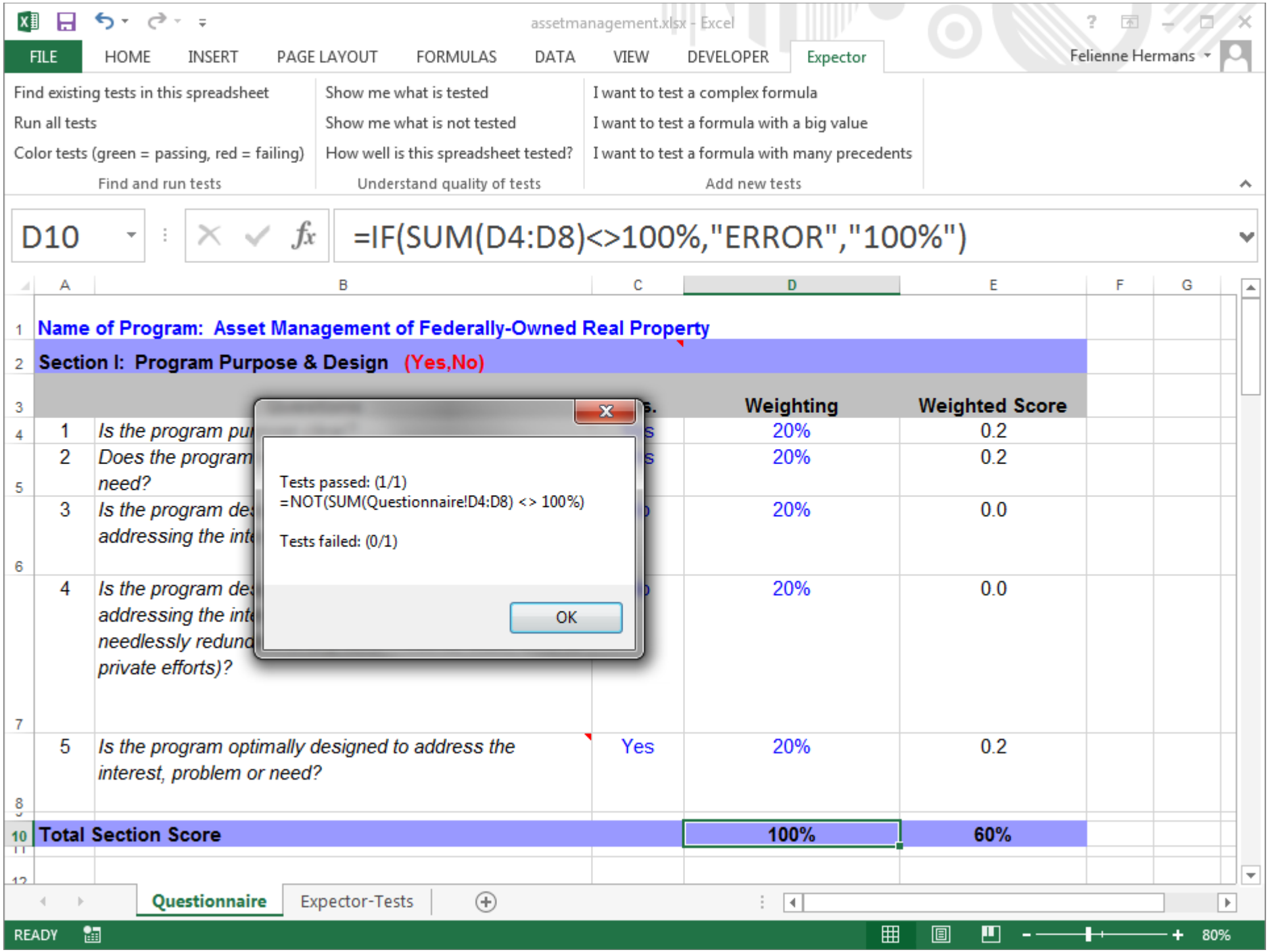
Section I: Program Purpose & Design (Yes,No)
Questions
Ans.
Weighting
Weighted Score
1 Is the program purpose clear? Yes 20% 0.2
2 Does the program address a specific interest, problem or need? Yes 20% 0.2
3 0.0
4 0.0
5 Is the program optimally designed to address the interest, problem or need? Yes 20% 0.2
Total Section Score 100% 60%
All tests detected
Save tests
Deselect all
The cell on Questionnaire!D10 expresses that SUM(D4:D8) should be 100%
Questionnaire
READY
80%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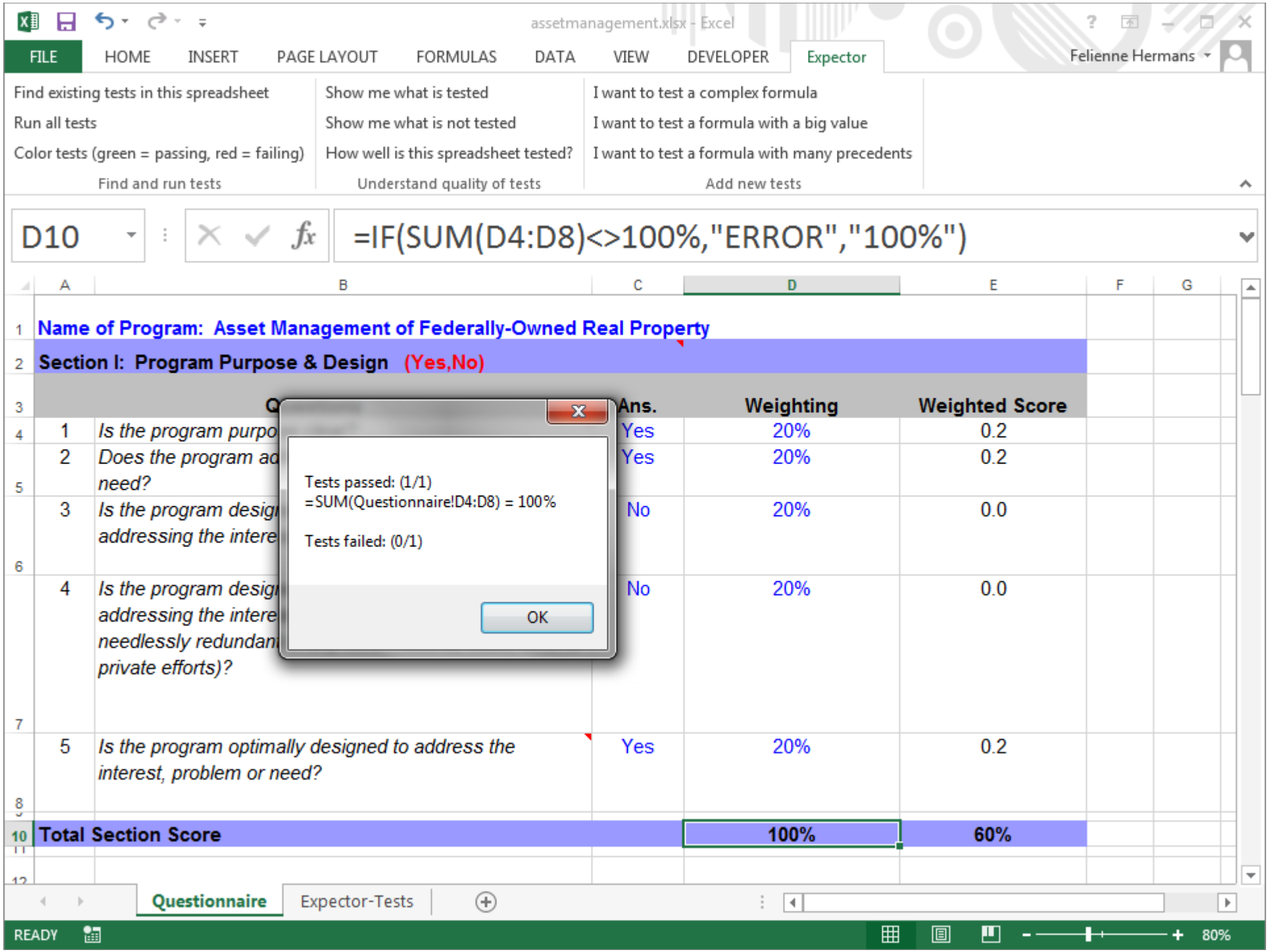
Weighting
Weighted Score
1 Is the program pu
20% 0.2
2 Does the program
need?
20% 0.2
3 Is the program de
addressing the int
20% 0.0
4 Is the program de
addressing the int
needlessly redund
private efforts)?
20% 0.0
5 Is the program optimally designed to address the interest, problem or need?
Yes
20% 0.2
Total Section Score
100% 60%
Tests passed: (1/1)
=NOT(SUM(Questionnaire!D4:D8) <> 100%)
Tests failed: (0/1)
OK
Questionnaire
Expector-Tests
READY
80%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Ans.
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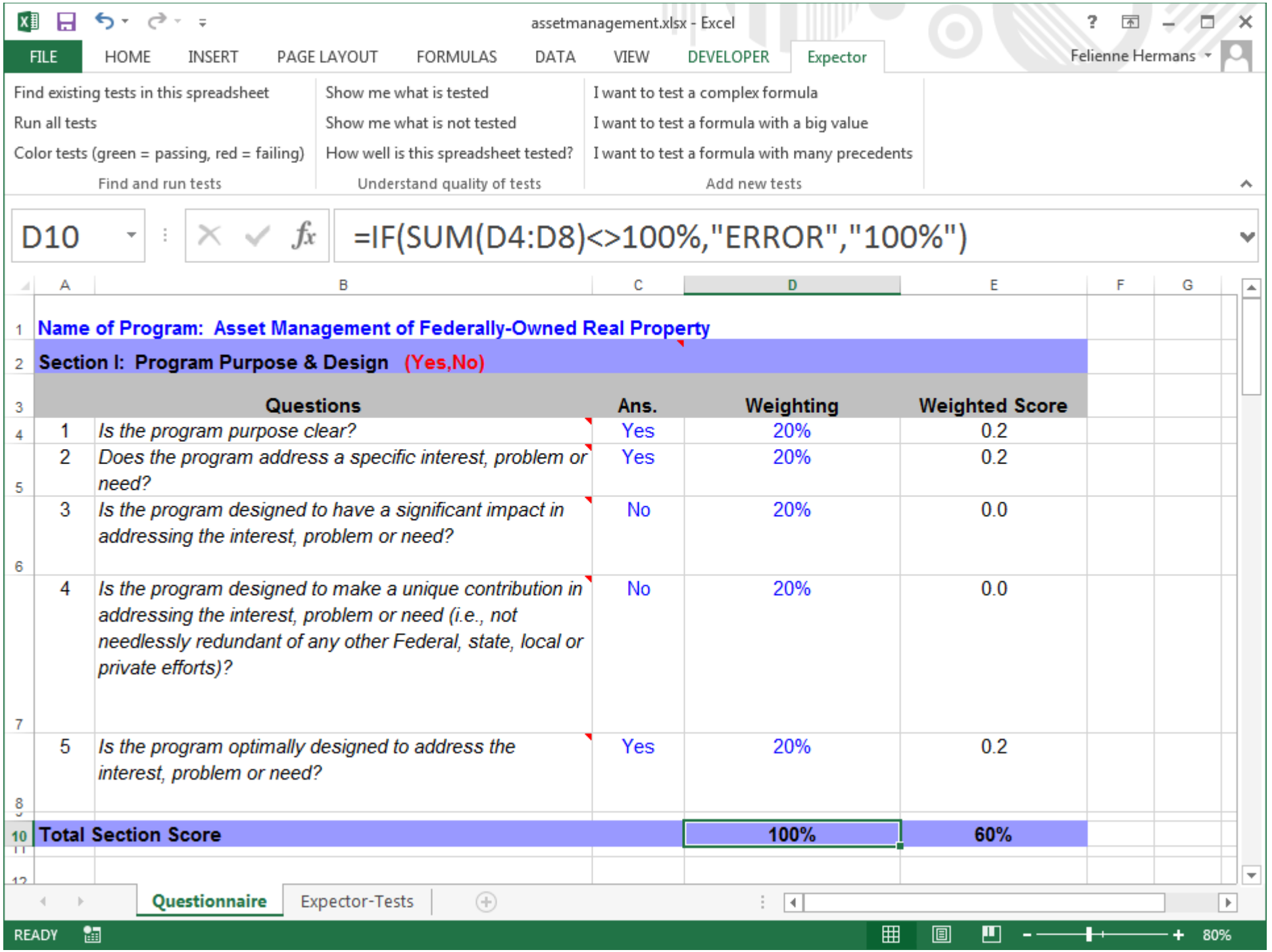
Weighted Score
1 Is the program purpo Yes 20% 0.2
2 Does the program ad Yes 20% 0.2
need?
3 Is the program desig No 20% 0.0
addressing the intere
4 Is the program desig No 20% 0.0
addressing the intere
needlessly redundan
private efforts)?
5 Is the program optimally designed to address the interest, problem or need? Yes 20% 0.2
Total Section Score 100% 60%
Tests passed: (1/1)
=SUM(Questionnaire!D4:D8) = 100%
Tests failed: (0/1)
OK
Questionnaire
Expector-Tests
READY
80%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Total Section Score 100% 60%
Questionnaire
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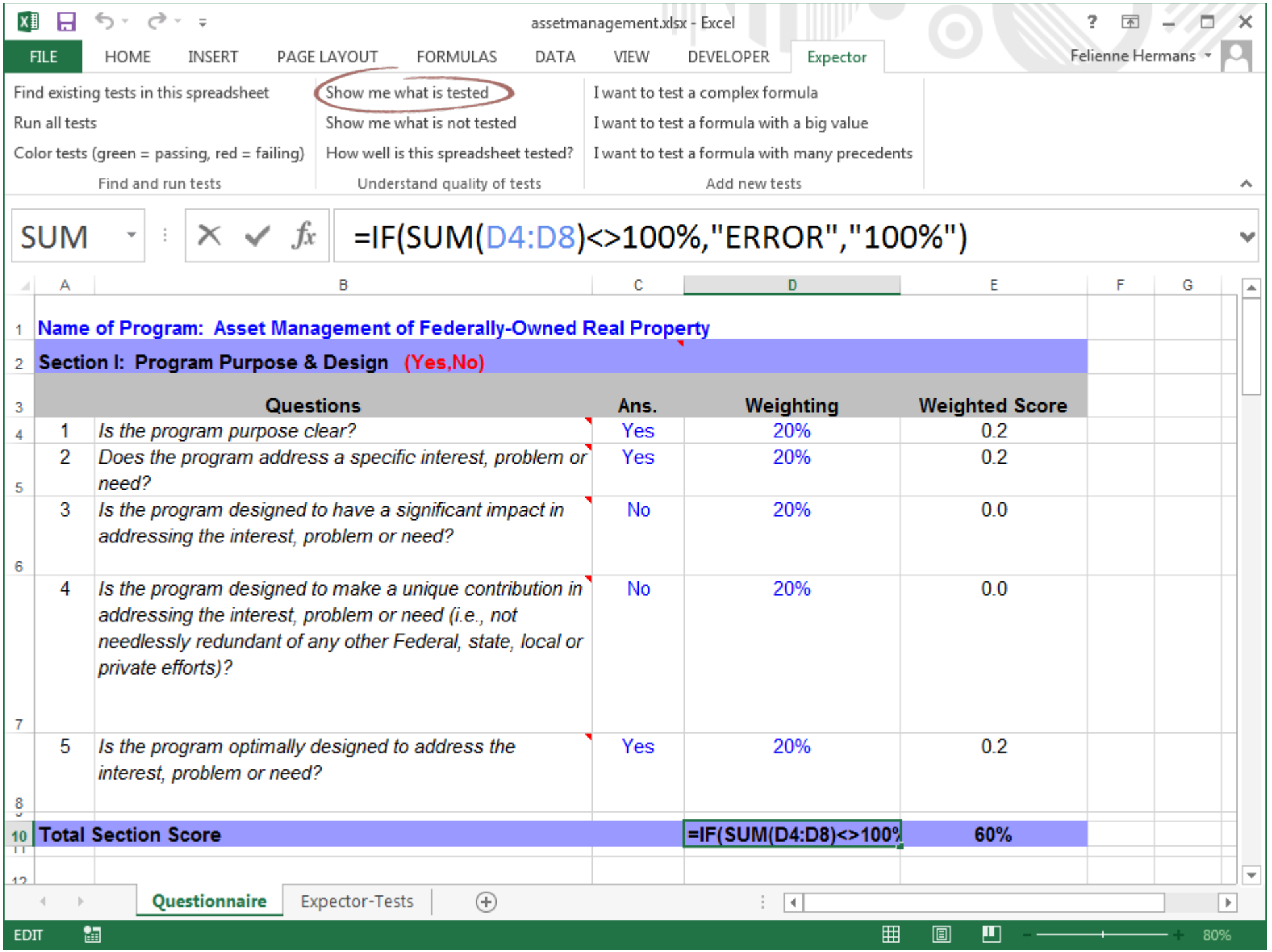
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Add new tests
SUM
=IF(SUM(D4:D8)<>100%,"ERROR","100%")
Name of Program: Asset Management of Federally-Owned Real Property
Section I: Program Purpose & Design (Yes,No)
Questions
Ans.
Weighting
Weighted Score
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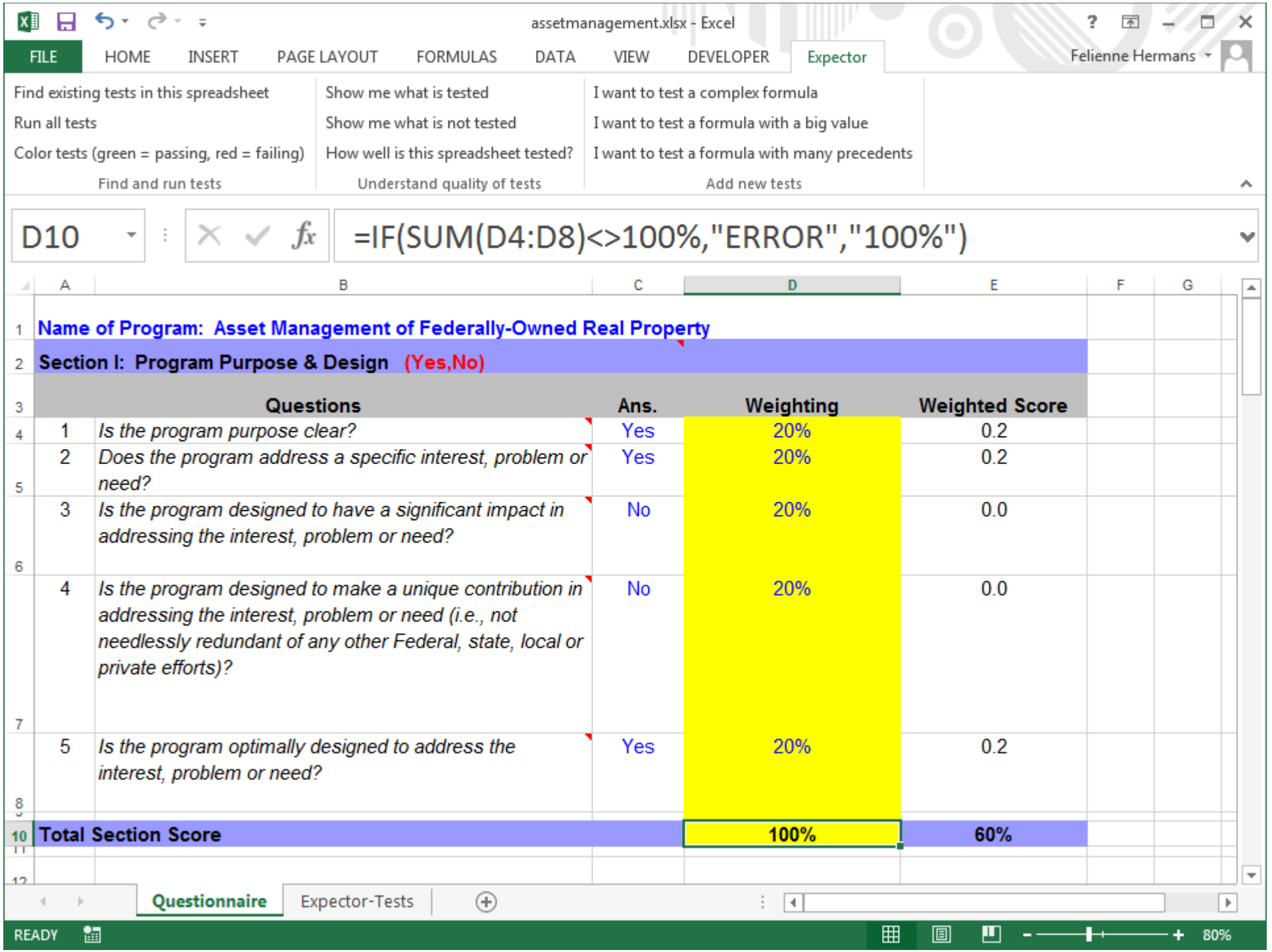
4 Is the program designed to make a unique contribution in addressing the interest, problem or need (i.e., not needlessly redundant of any other Federal, state, local or private efforts)? No 20% 0.0
5 Is the program optimally designed to address the interest, problem or need? Yes 20% 0.2
Total Section Score
=IF(SUM(D4:D8)<>100%
60%
Questionnaire
Expector-Tests
EDIT
80%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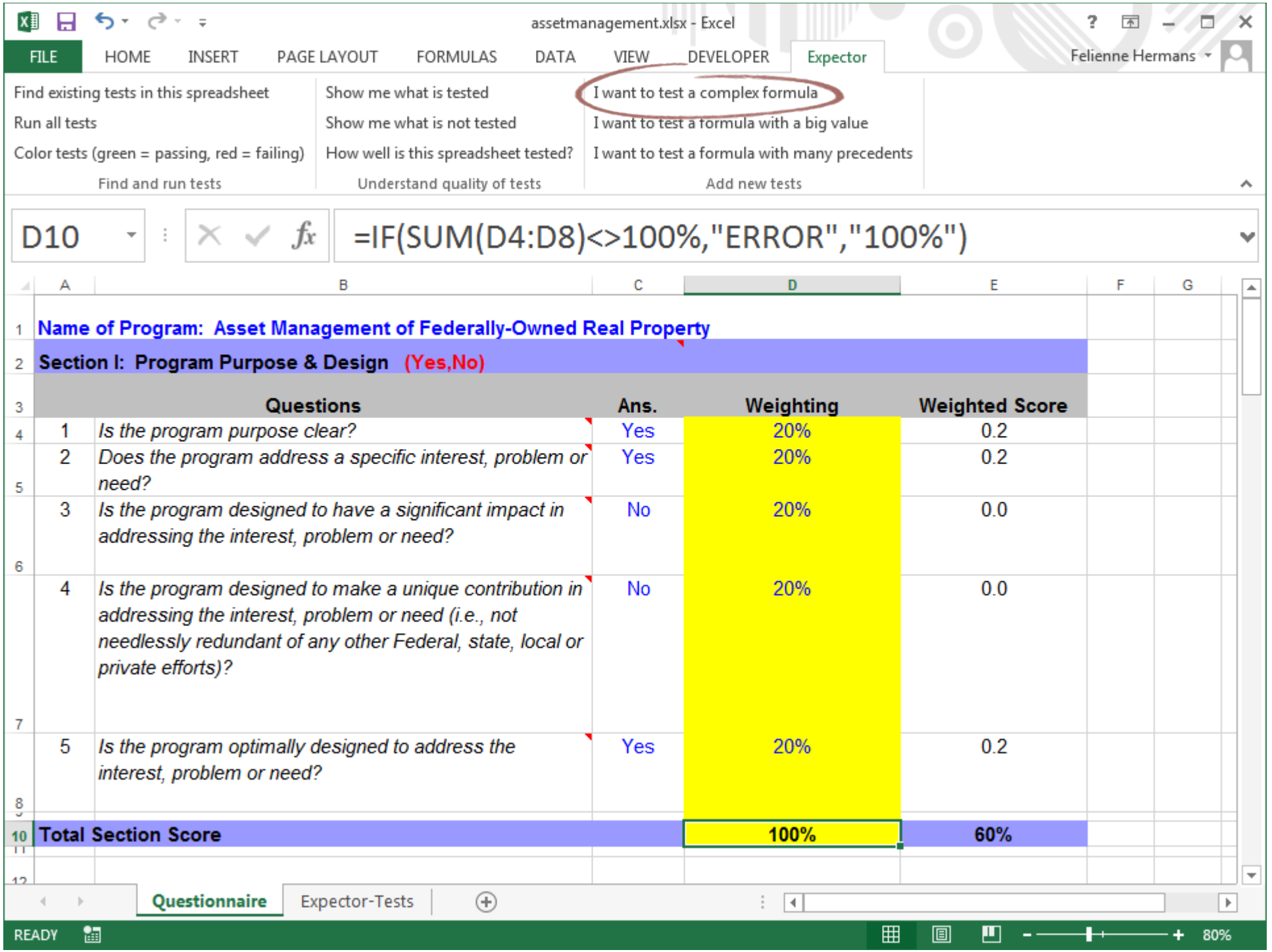
Total Section Score 100% 60%
Questionnaire
Expector-Tests
READY
80%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5 Is the program optimally designed to address the interest, problem or need? Yes 20% 0.2
Total Section Score 100% 60%
Questionnaire
Expector-Tests
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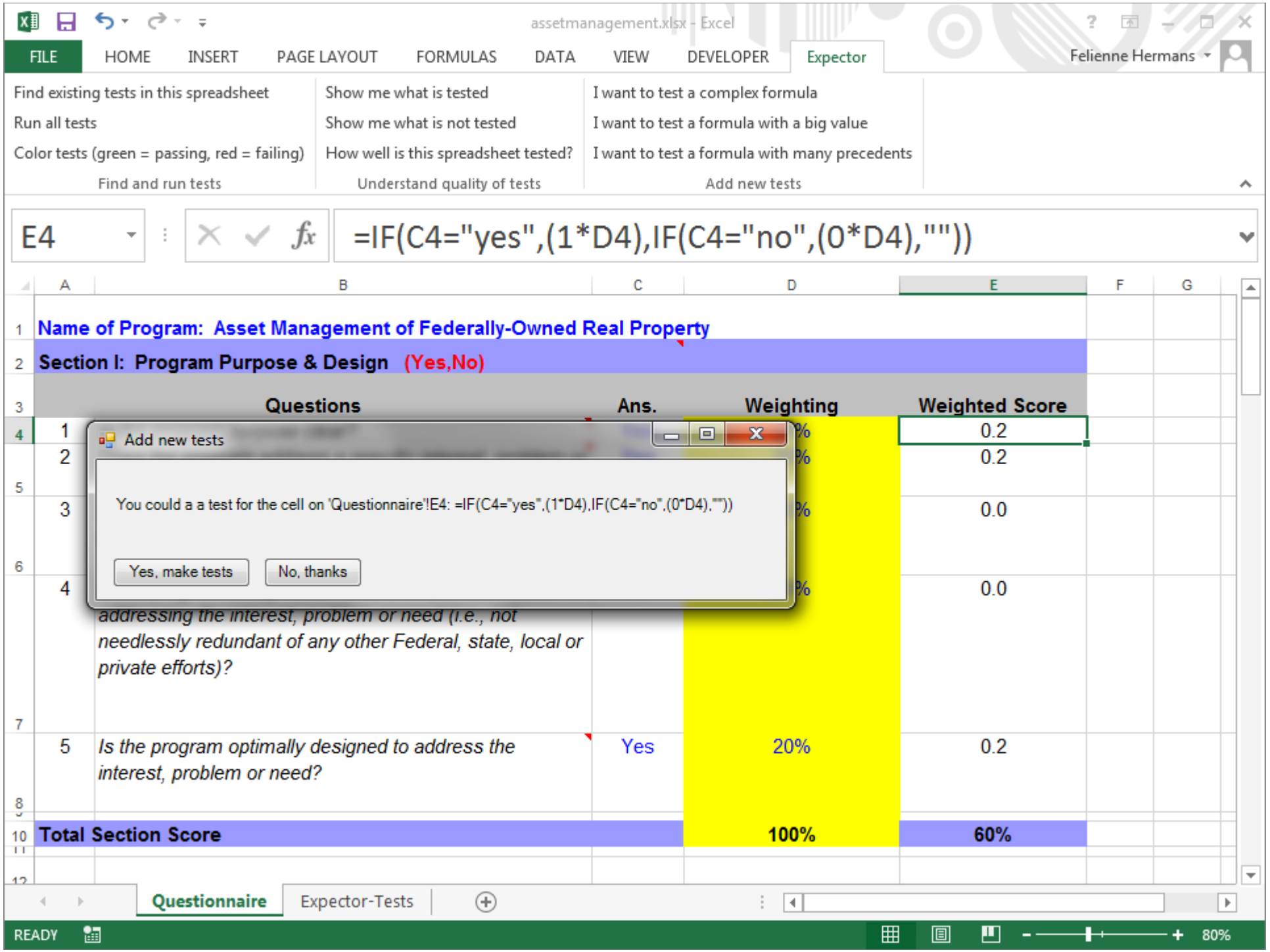
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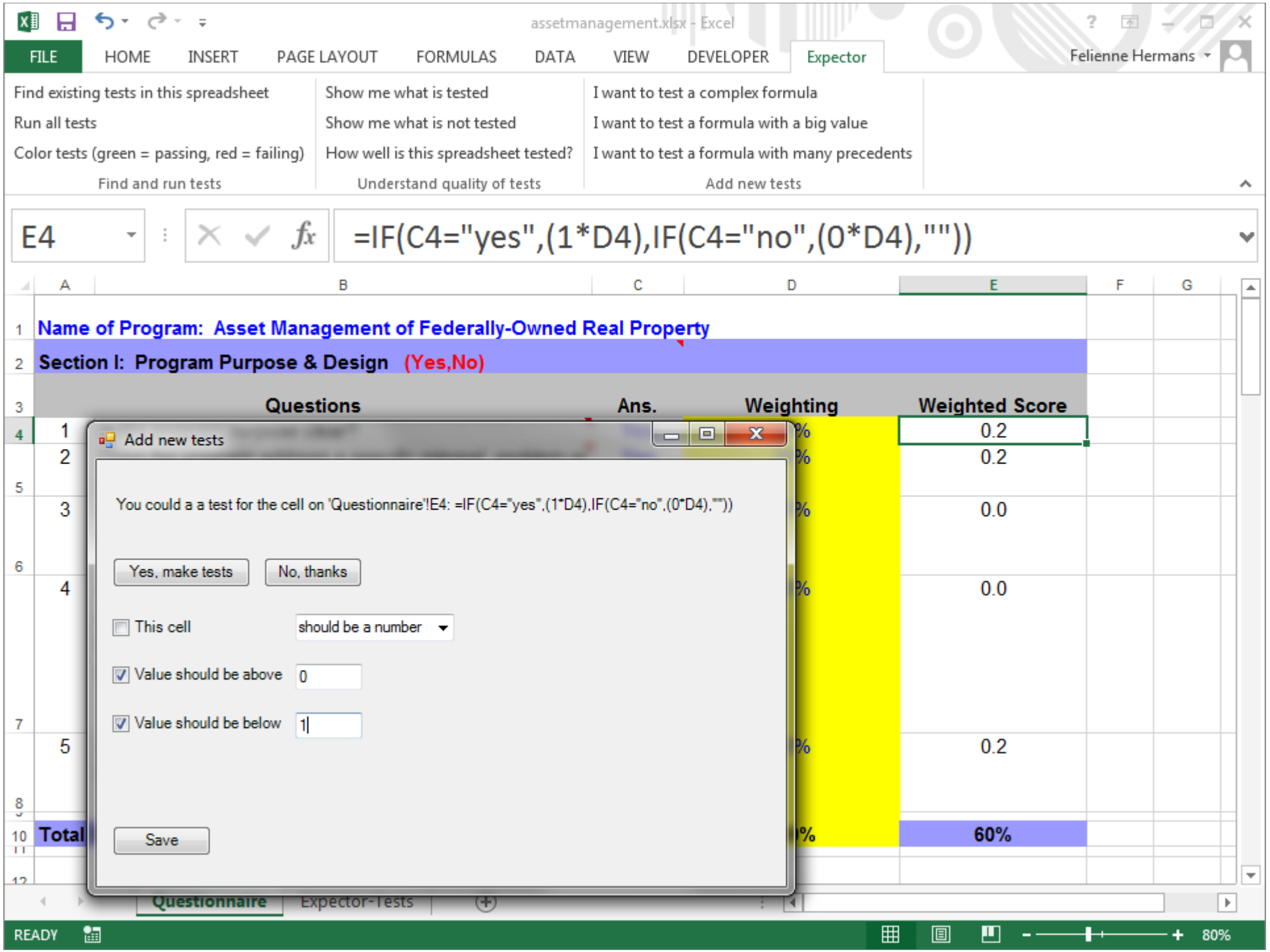
Show me what is not tested
How well is this spreadsheet tested?
Understand quality of tests
I want to test a complex formula
I want to test a formula with a big value
I want to test a formula with many precedents
Add new tests
E4
=IF(C4="yes",(1*D4),IF(C4="no",(0*D4),""))
Name of Program: Asset Management of Federally-Owned Real Property
Section I: Program Purpose & Design (Yes,No)
Questions
Ans.
Weighting
Weighted Score
1
0.2
2
0.2
3
0.0
4
addressing the interest, problem or need (i.e., not needlessly redundant of any other Federal, state, local or private efforts)?
0.0
5
Is the program optimally designed to address the interest, problem or need?
Yes
20%
0.2
Total Section Score
100%
60%
Add new tests
You could a a test for the cell on 'Questionnaire'!E4: =IF(C4="yes",(1*D4),IF(C4="no",(0*D4),""))
Yes, make tests
No, thanks
Questionnaire
Expector-Tests
READY
80%


assetmanagement.xlsx - Excel
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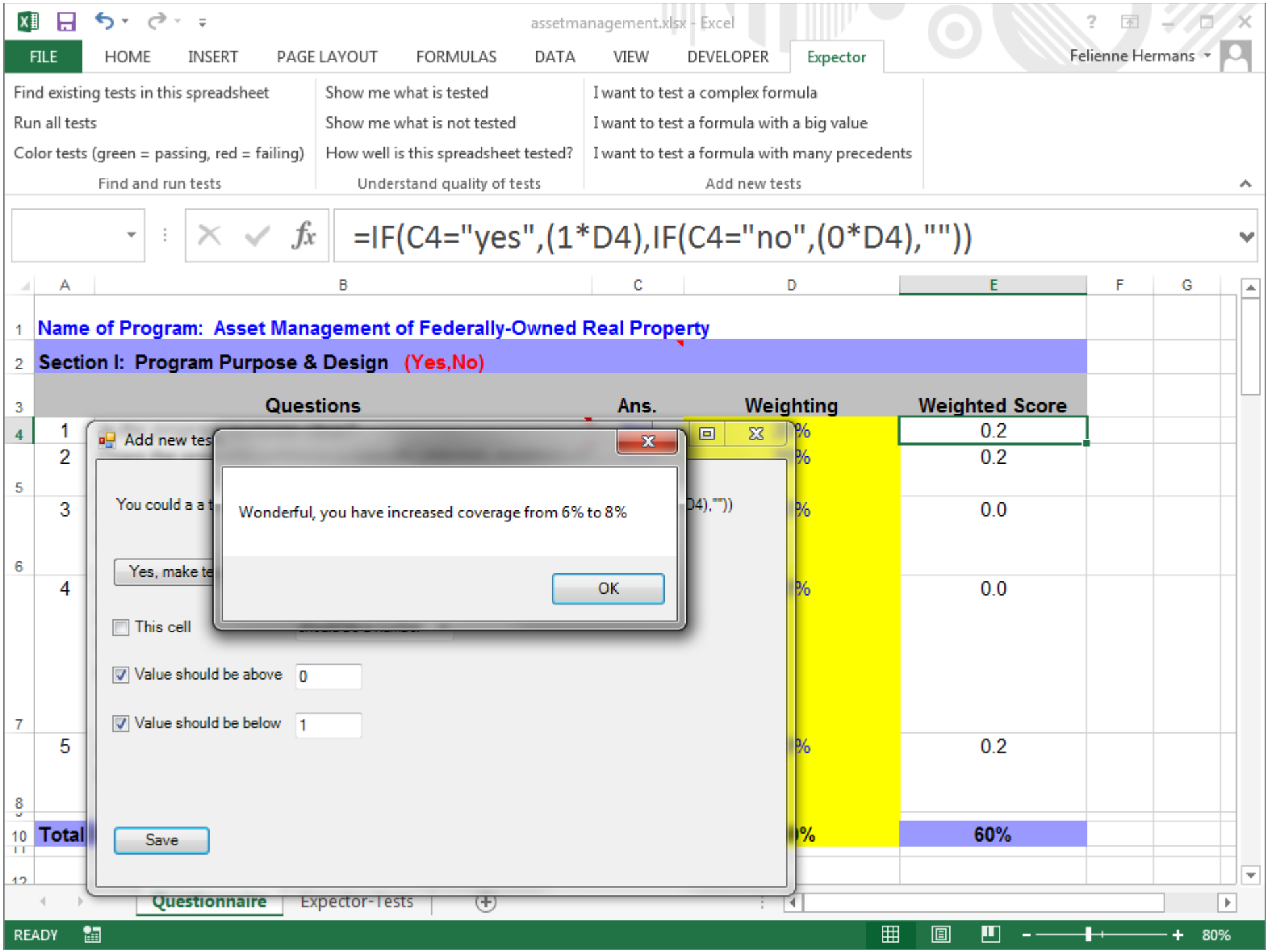
I want to test a formula with a big value
I want to test a formula with many precedents
Add new tests
E4
=IF(C4="yes",(1*D4),IF(C4="no",(0*D4),""))
Name of Program: Asset Management of Federally-Owned Real Property
Section I: Program Purpose & Design (Yes,No)
Questions
Ans.
Weighting
Weighted Score
0.2
0.2
0.0
0.0
0.2
Total
60%
Add new tests
You could a a test for the cell on 'Questionnaire'!E4: =IF(C4="yes",(1*D4),IF(C4="no",(0*D4),""))
Yes, make tests
No, thanks
This cell
should be a number
Value should be above
0
Value should be below
1
Save
Questionnaire
Expector-Tests
READY
80%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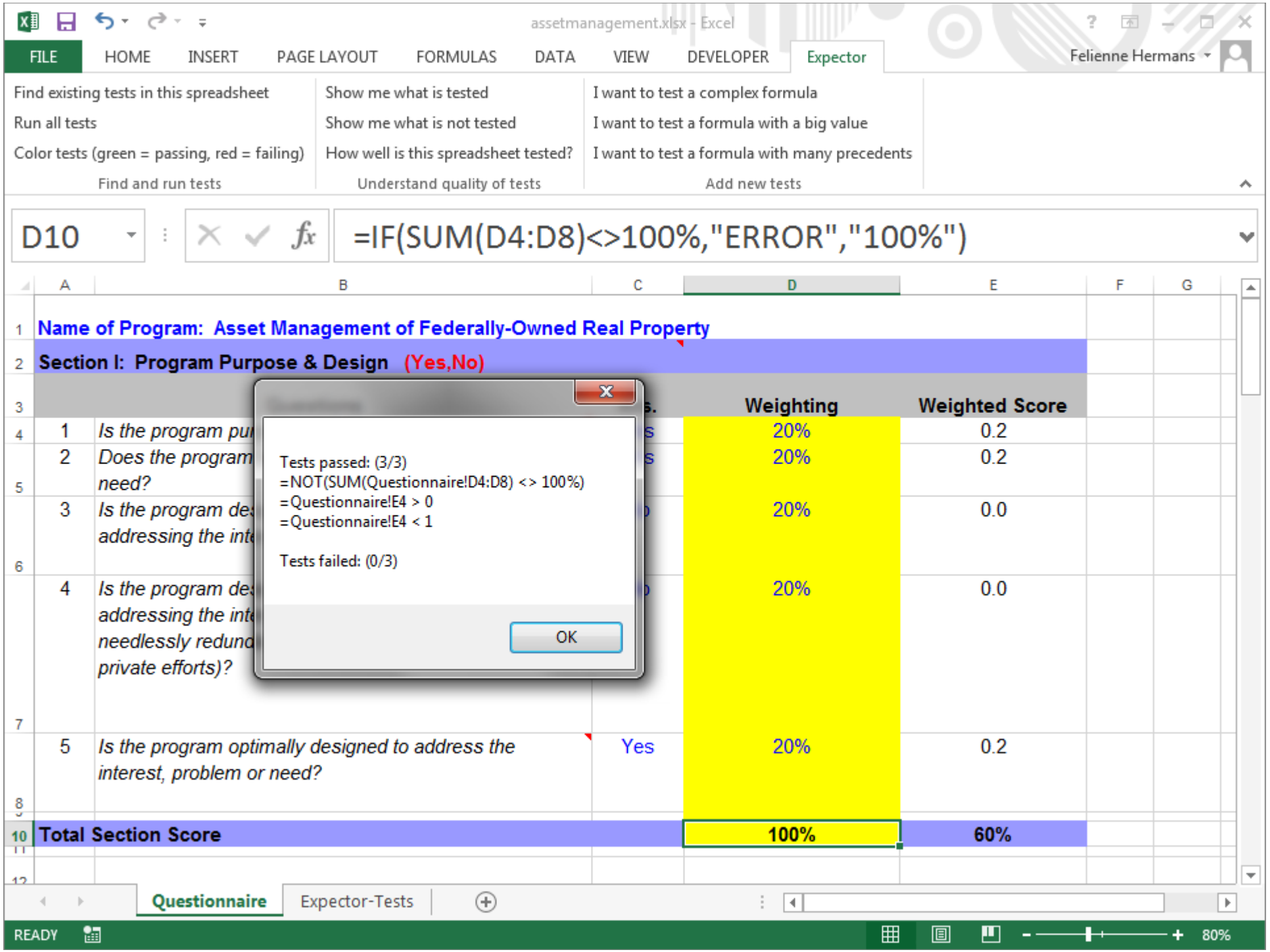
Add new tests
=IF(C4="yes",(1*D4),IF(C4="no",(0*D4),""))
Name of Program: Asset Management of Federally-Owned Real Property
Section I: Program Purpose & Design (Yes,No)
Questions
Ans.
Weighting
Weighted Score
0.2
0.2
0.0
0.0
0.2
Total
60%
Add new tes
You could a a t
D4),""))
Yes, make te
This cell
Value should be above
0
Value should be below
1
Save
Wonderful, you have increased coverage from 6% to 8%
OK
Questionnaire
Expector-Tests
READY
80%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Name of Program: Asset Management of Federally-Owned Real Property
Section I: Program Purpose & Design (Yes,No)
Weighting
Weighted Score
1 Is the program pu 20% 0.2
2 Does the program 20% 0.2
need?
3 Is the program de 20% 0.0
addressing the int
4 Is the program de 20% 0.0
addressing the int
needlessly redund
private efforts)?
5 Is the program optimally designed to address the interest, problem or need? Yes 20% 0.2
Total Section Score 100% 60%
Tests passed: (3/3)
=NOT(SUM(Questionnaire!D4:D8) <> 100%)
=Questionnaire!E4 > 0
=Questionnaire!E4 < 1
Tests failed: (0/3)
OK
Questionnaire
Expector-Tests
READY
80%


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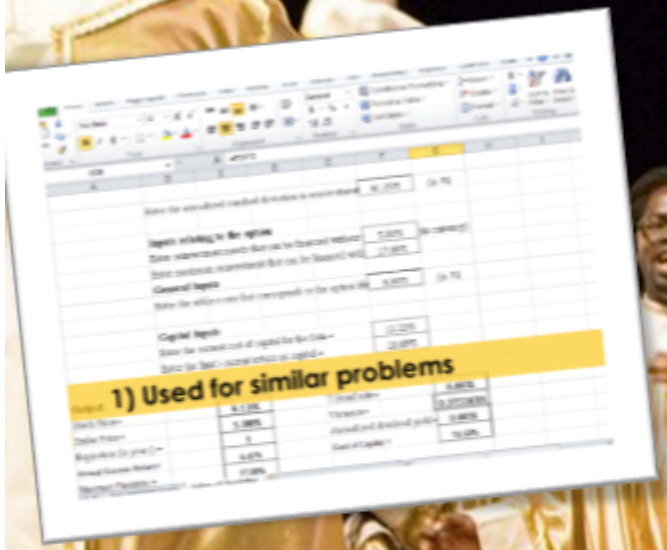
felienne.com/expector


Spreadsheets are code

Spreadsheets are code



1) Used for similar problems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2) Formulas are Turing complete


Spreadsheets are code
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2) Formulas
Only 33% o
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Average sheet is u
people
Spreadsheets can have a long life
5 years on average
3) They suffer from the same problems


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1) Used f
2) Formulas
3) They suffer
live programming


Spreadsheets are code
1) Used f
2) Formulas
3) They suffer
live programming
pure functional
Excel
A Purely Functional Languag
featuring static typing, higher-order function
polymorphism, type classes and monadic effec


Spreadsheets are code
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2) Formulas
3) They suffer
live programming
pure functional
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A Purely
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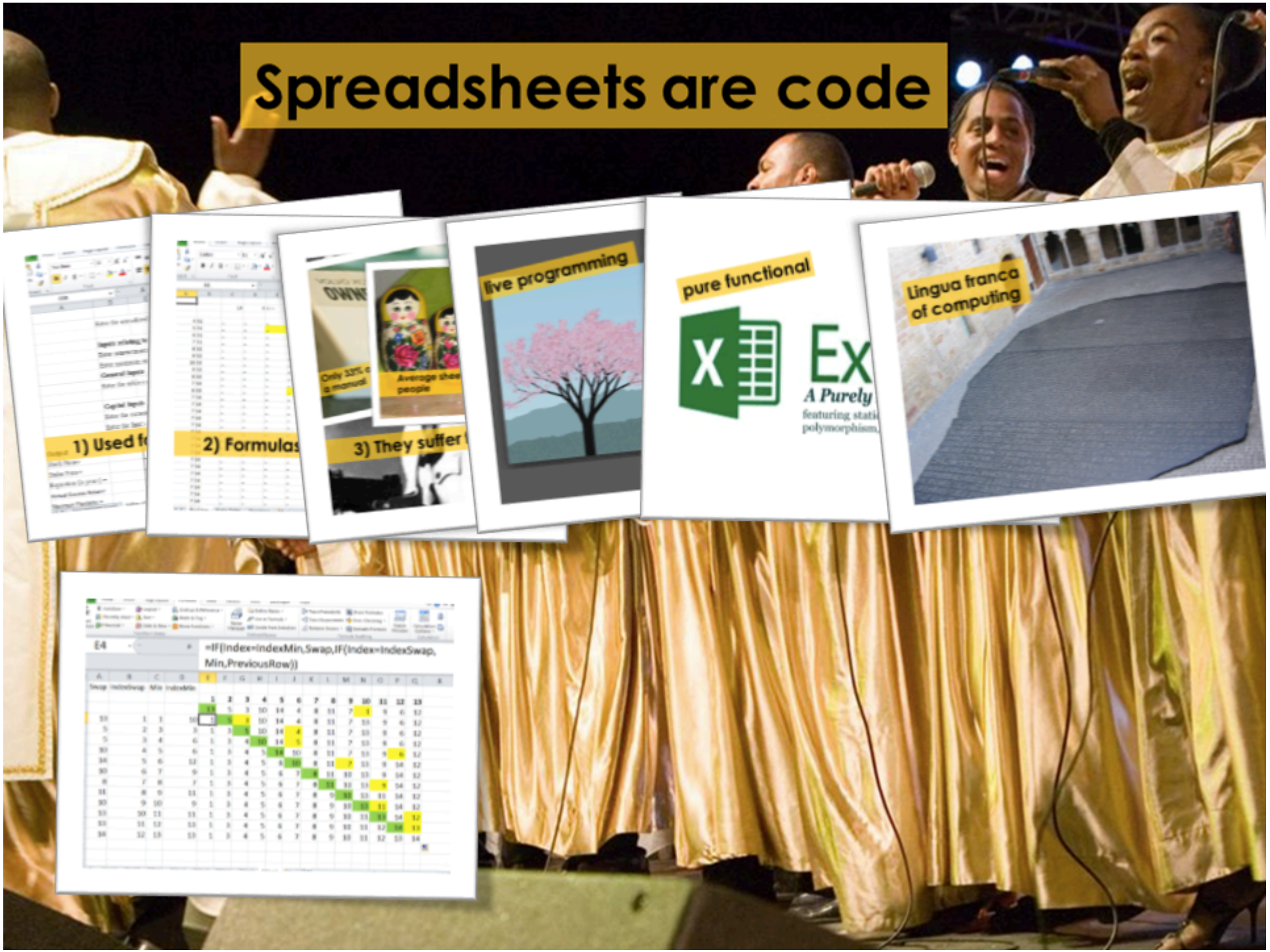
of computing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1) Used f
2) Formulas
3) They suffer
live programming
pure functional
Ex
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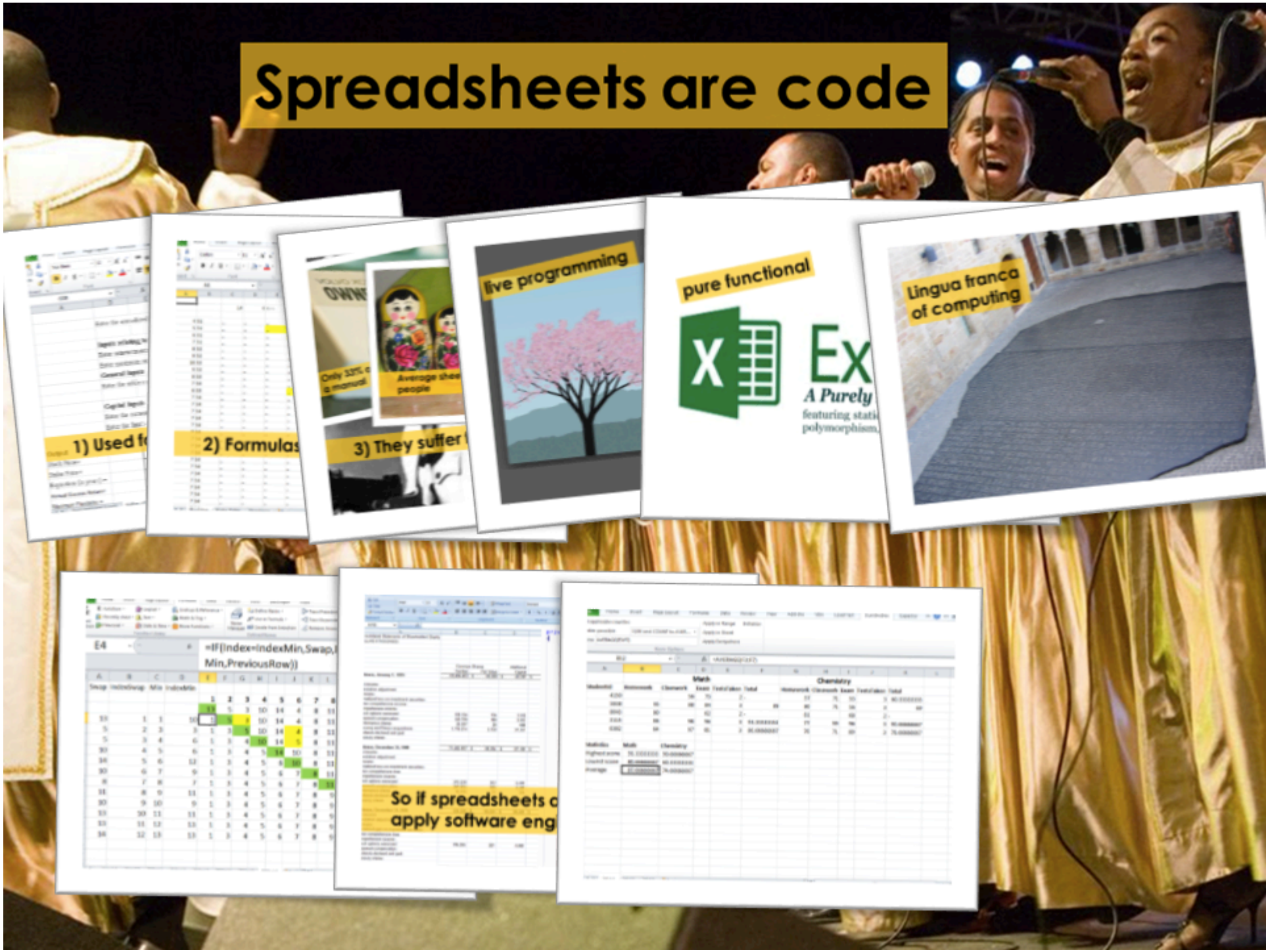
featuring stati
polymorphism.
Lingua franca
of computing
E4
=IF(Index=IndexMin,Swap,IF(Index=IndexSwap,
Min,PreviousRow))

Spreadsheets are code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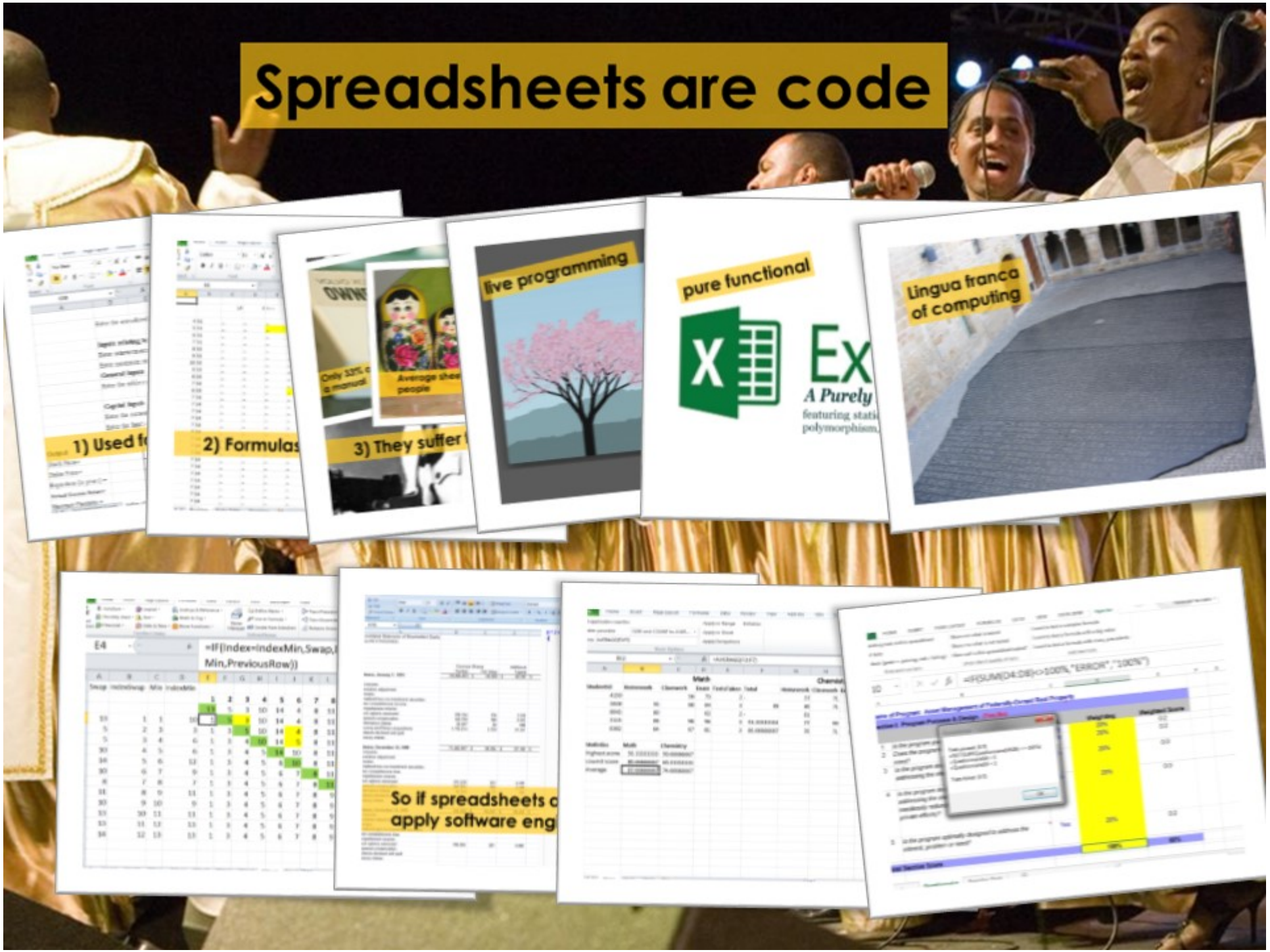
So if spreadsheets
apply software eng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So if spreadsheets
apply software eng

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- www.spreadsheetlab.org

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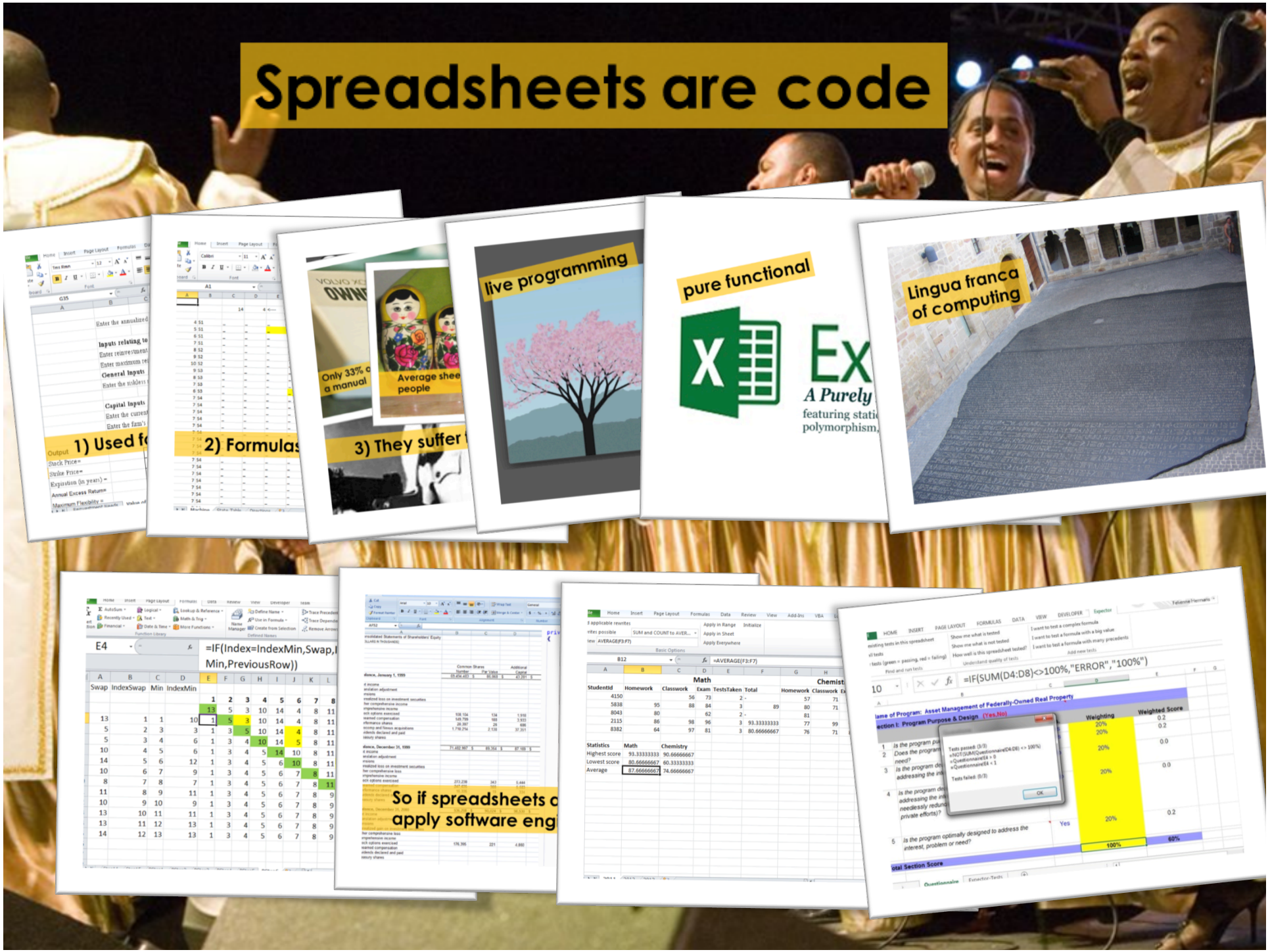
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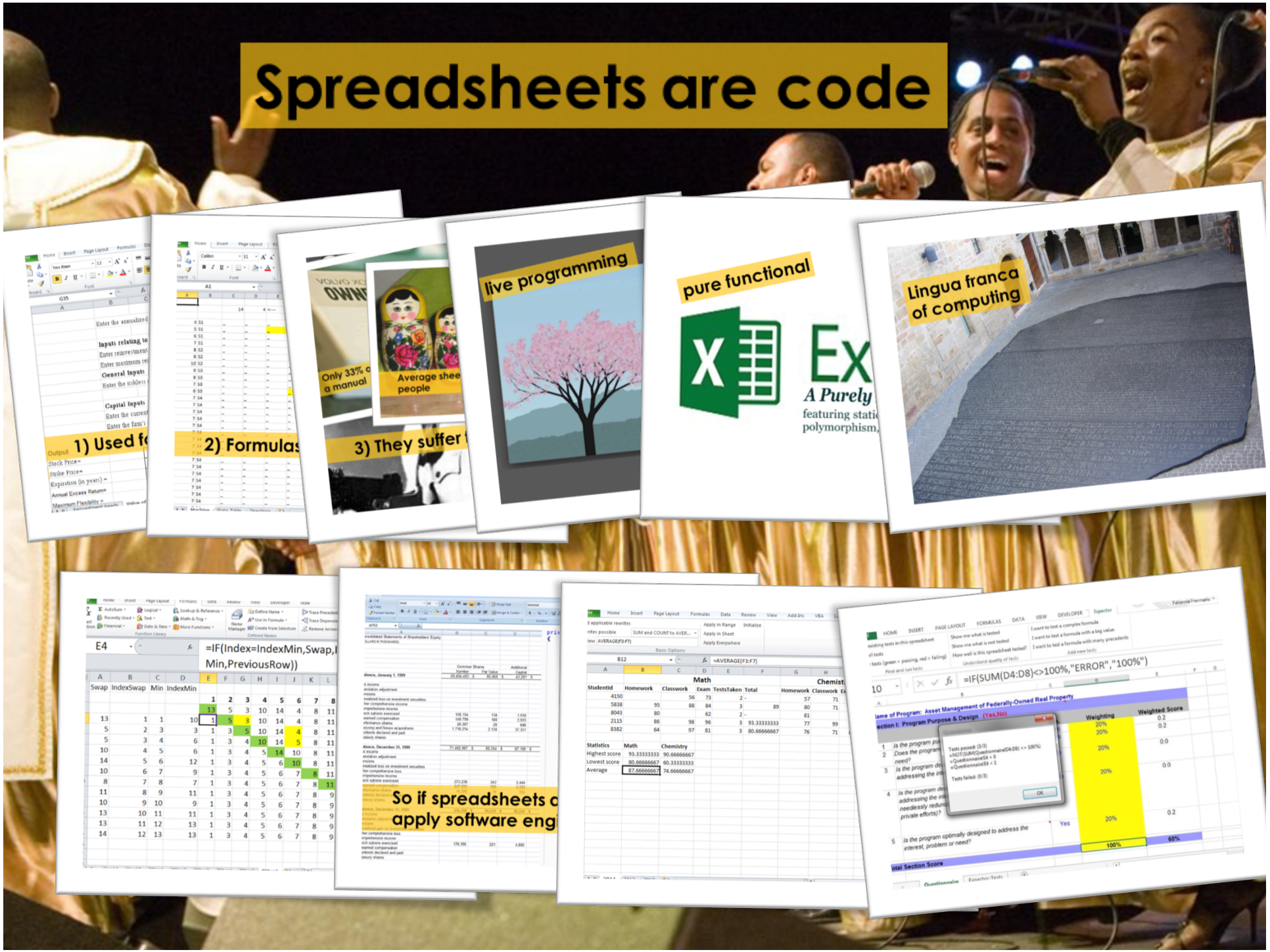
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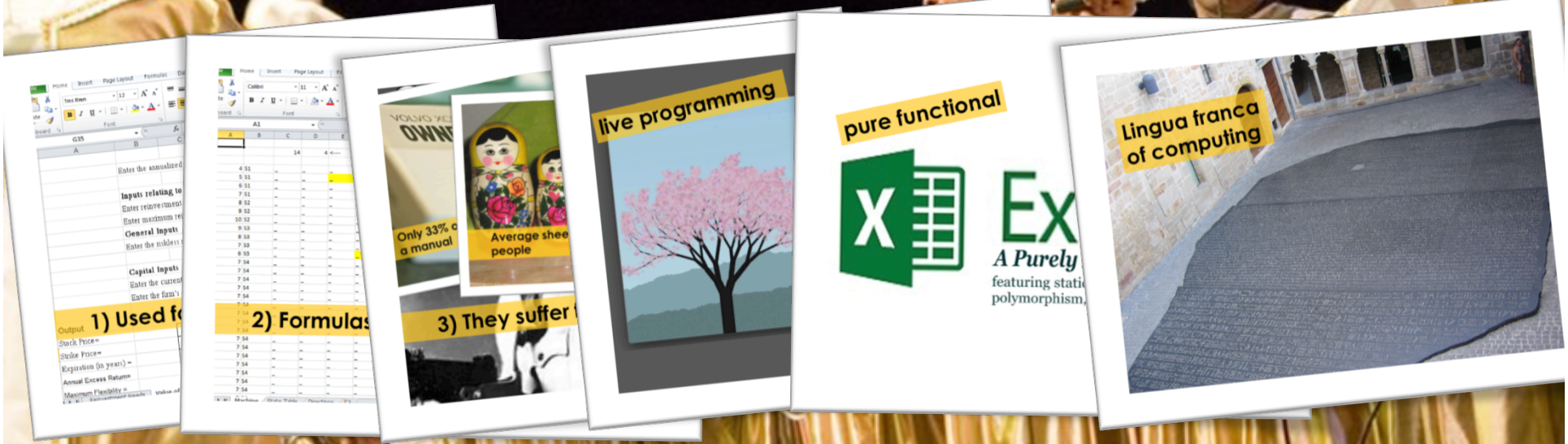
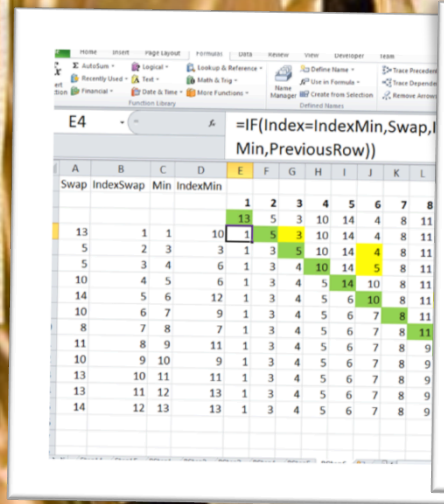
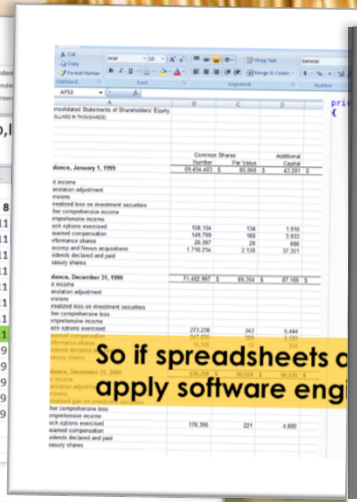
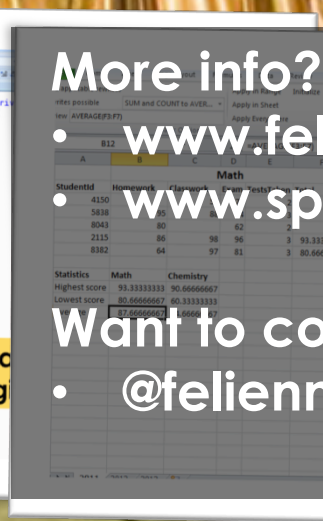
apply software eng

Spreadsheets are code









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- www.felienne.com
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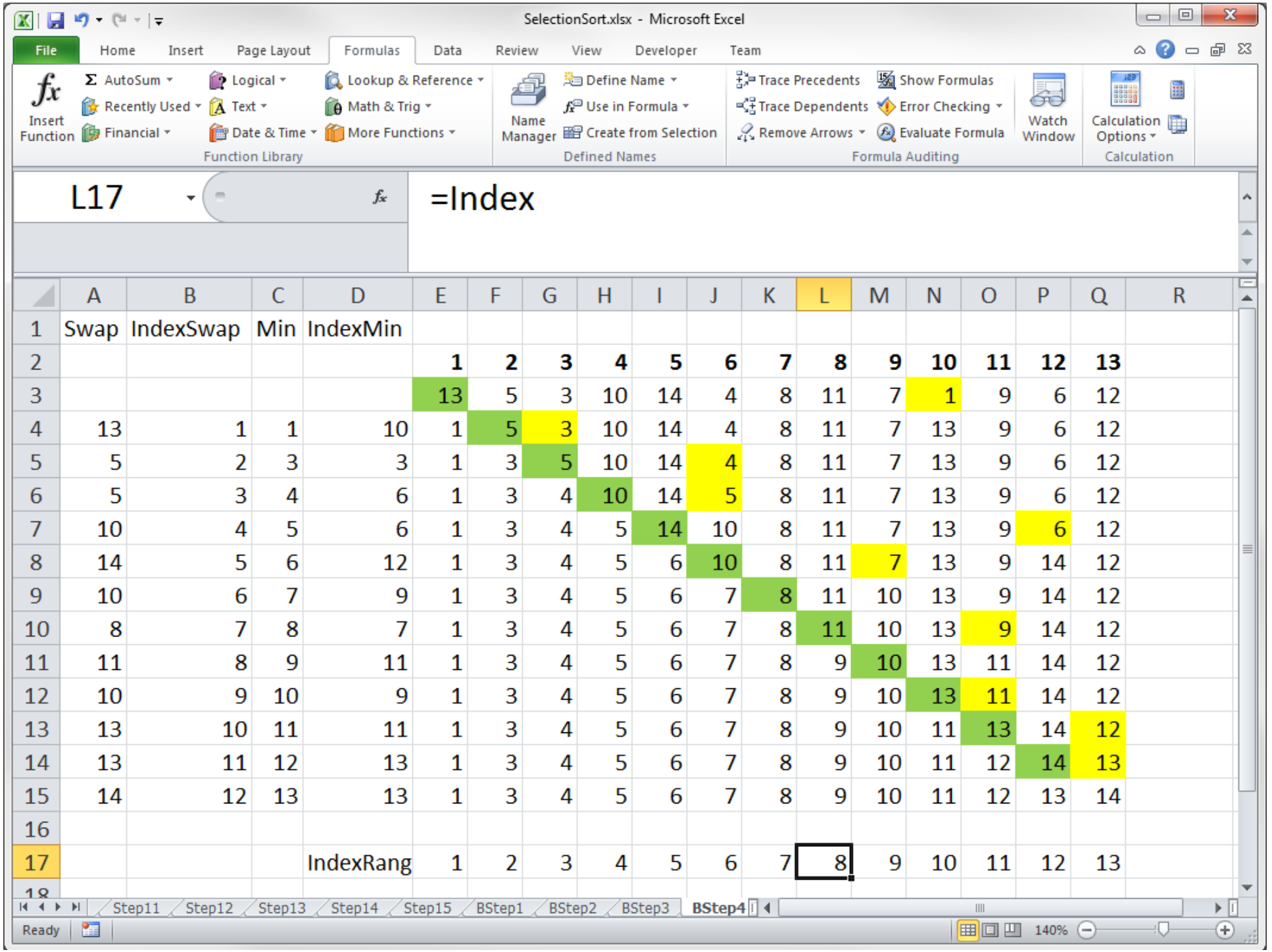

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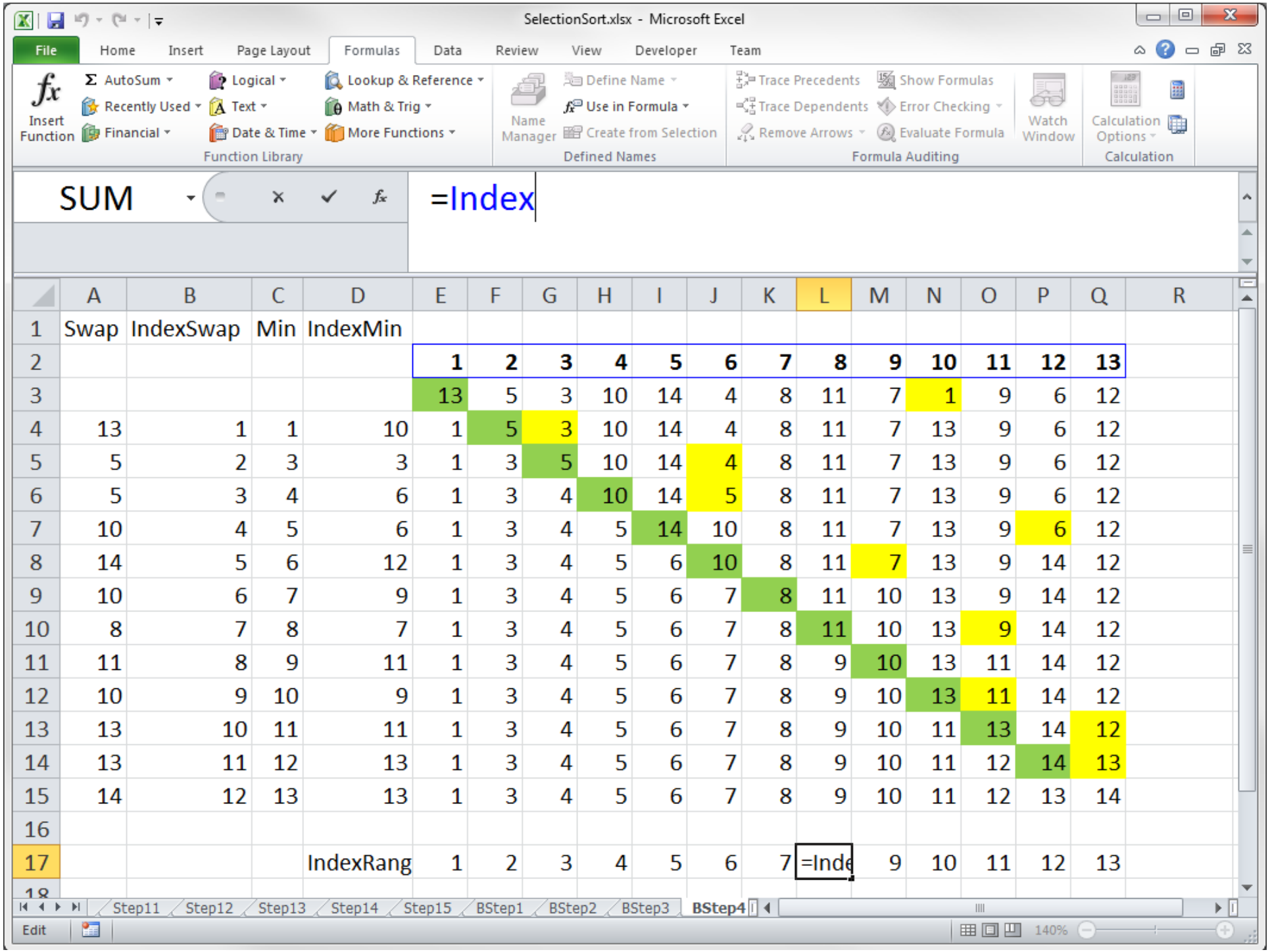

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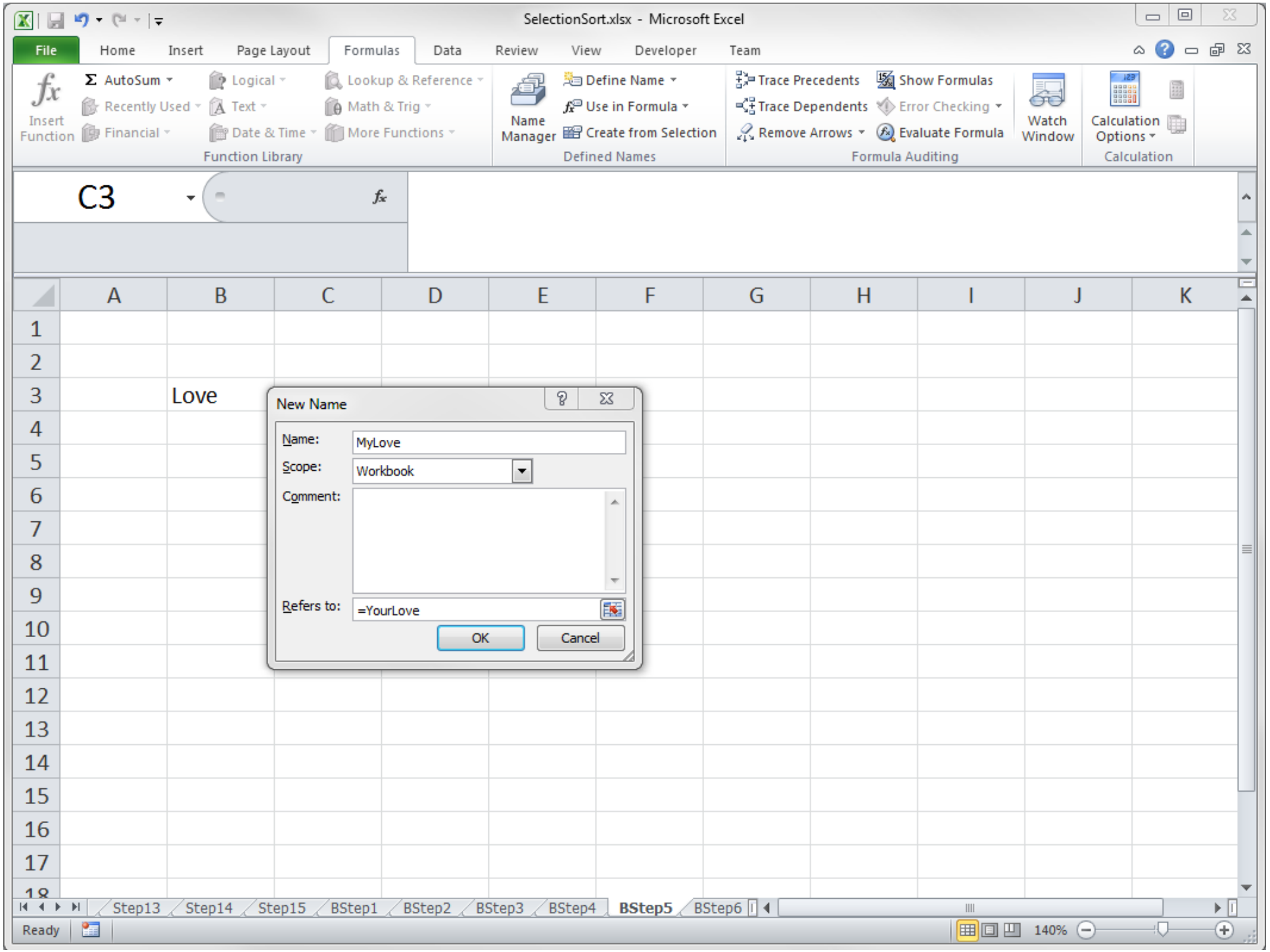
18																		


Whitney
Houston
my love is
your love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Use in Formula
Create from Selection
Name Manager
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Trace Precedents
Trace Dependents
Remove Arrows
Show Formulas
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Evaluate Formula
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MyLove
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Workbook
Comment:
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=YourLove
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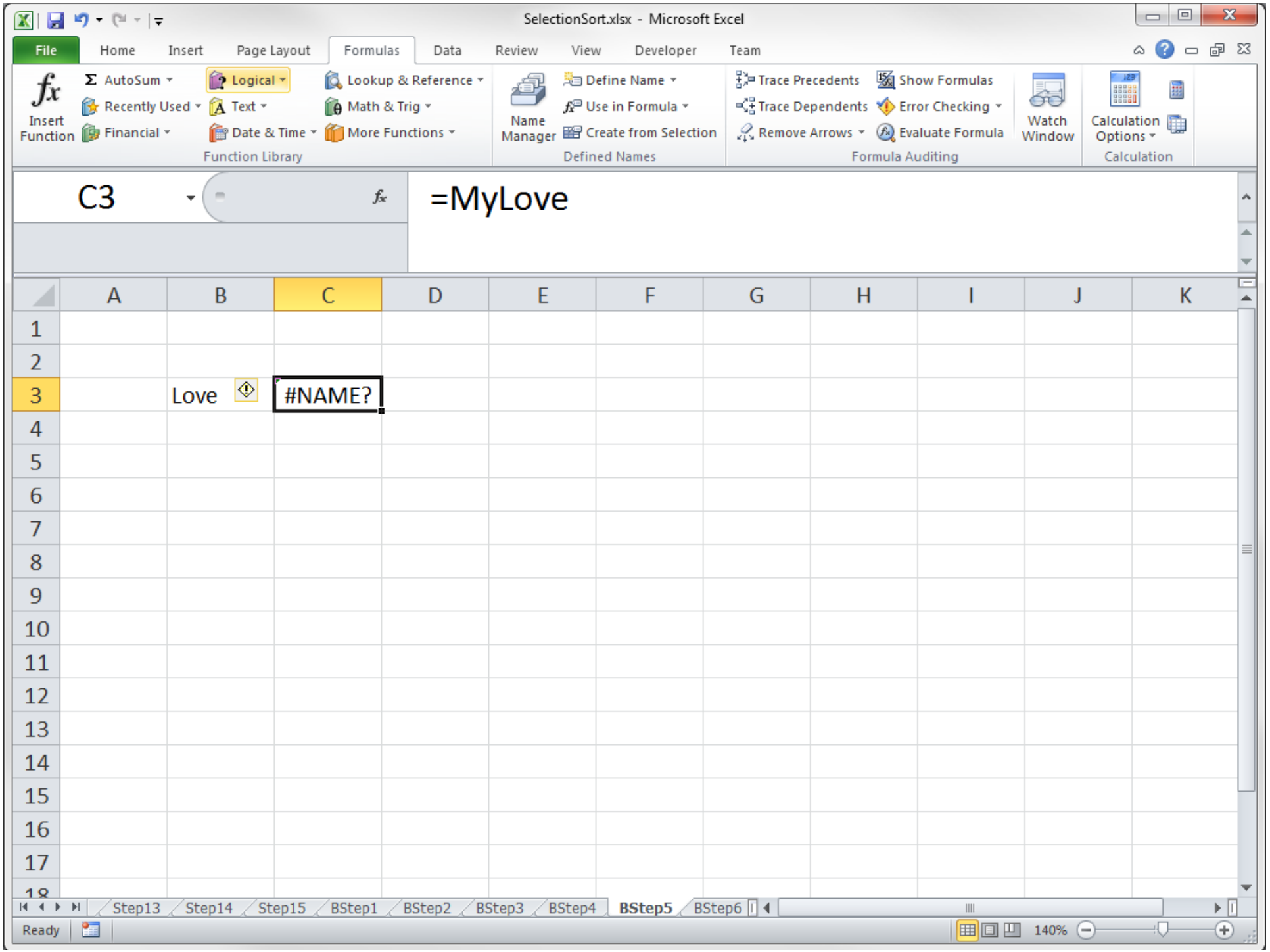
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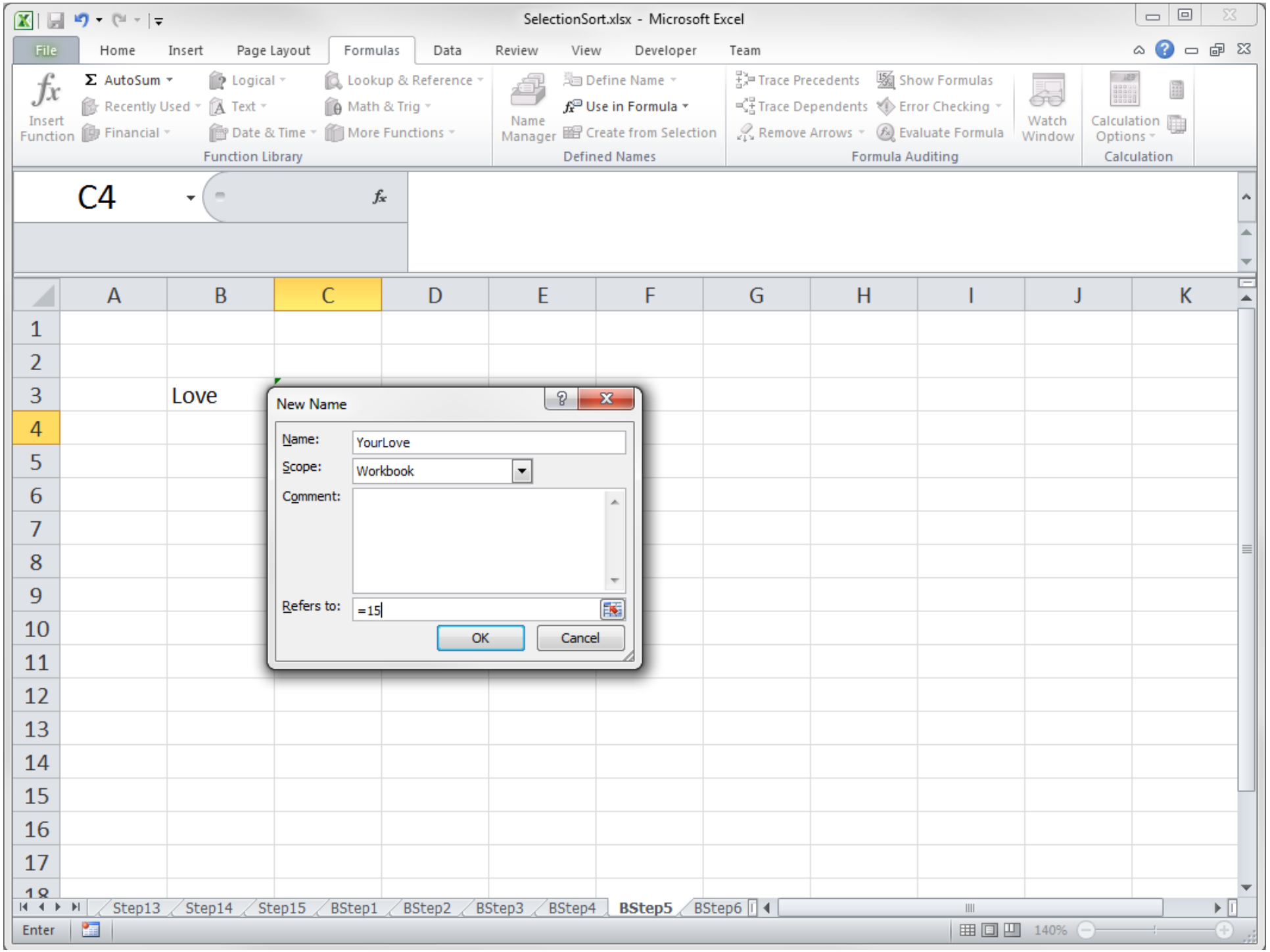
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Watch Window
Calculation Options
Calculation
C4
Love
New Name
Name: YourLove
Scope: Workbook
Comment:
Refers to: =15
OK
Cancel
Step13
Step14
Step15
BStep1
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BStep6
Enter
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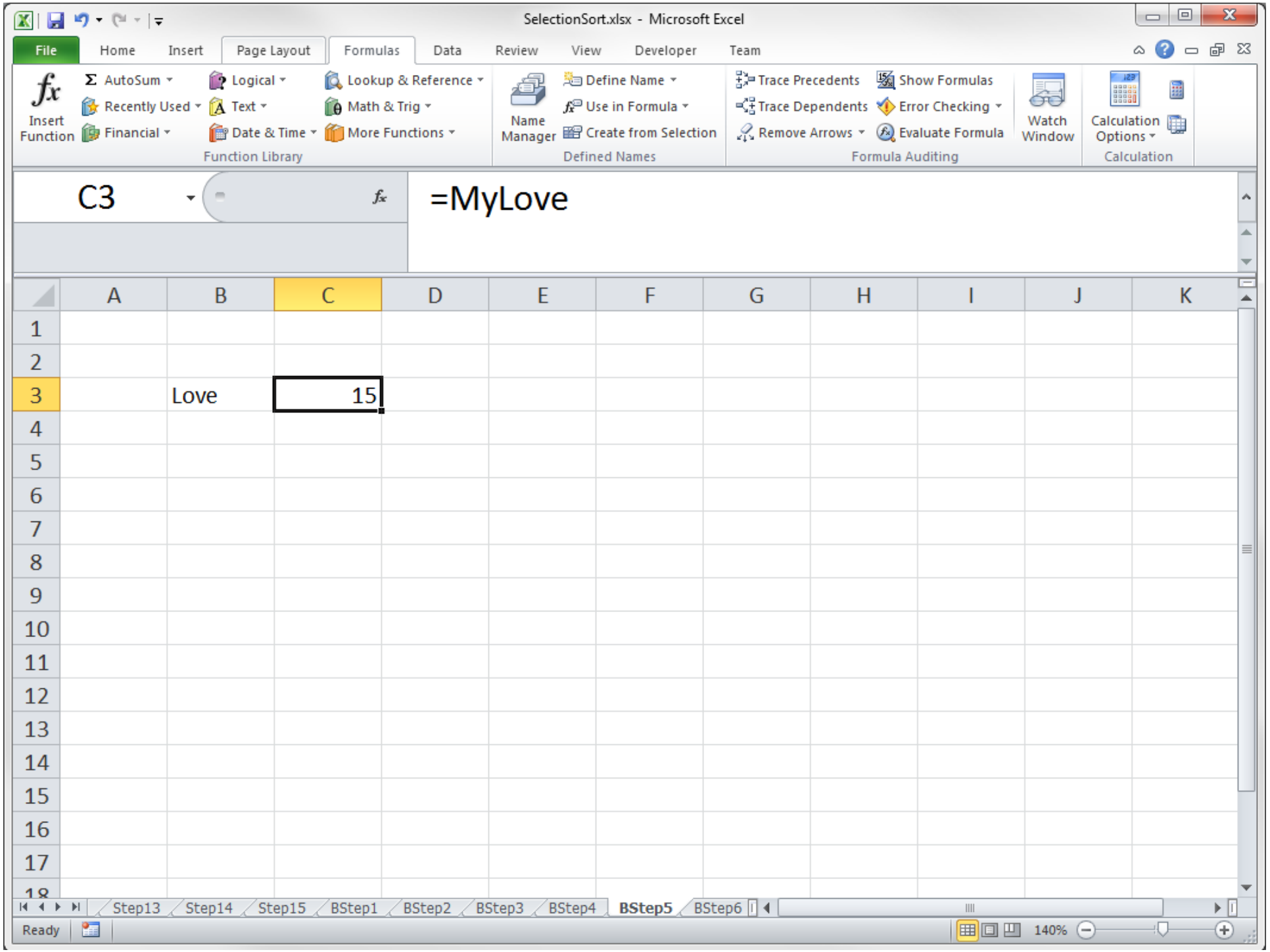
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