EXCEL WORKSHOP II: INTERMEDIATE EXCEL

With Applications from Reserving

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INDEX(array, row_num, [column_num])

	A	B	C	D	E	F	G
1	A1	B1	C1	D1		**Formula**	**Output**
2	A2	B2	C2	D2		=INDEX($A$1:$D$4,2,3)	C2
3	A3	B3	C3	D3		=INDEX($A$1:$D$4,4,1)	A4
4	A4	B4	C4	D4			

- Returns the value of **array** in the position by **row_num** and **[column_num]**

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MATCH(lookup_value, lookup_array, [match_type])

	A	B	C	D
1	*Name*		**Formula**	**Output**
2	Joe Bruin		=MATCH("Joe Bruin",$A$2:$A$4,0)	1
3	John Doe		=MATCH("Jane Doe",$A$2:$A$4,0)	3
4	Jane Doe		=MATCH("Johnny",$A$2:$A$4,0)	#N/A

- Similar to VLOOKUP, searches for **lookup_value** in a one-dimensional **lookup_array**
- Returns the index of the value
- **[match_type]**
  - 1 (DEFAULT): finds largest value <= **lookup_value** (**lookup_array** must be sorted ascending)
  - 0: finds first value = **lookup_value**
  - -1: finds smallest value >= **lookup_value** (**lookup_array** must be sorted descending)

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INDEX and MATCH can be combined to create a more powerful, error-resistant VLOOKUP

- VLOOKUP requires us to count how many columns over the return value is found
- VLOOKUP can only search for *lookup_value* in the **first** column of *table_array*
- If we insert a column, VLOOKUP will either return the wrong column's value or break completely
- INDEX MATCH allows us to look up across both rows and columns, whereas VLOOKUP and HLOOKUP only allow one dimension

Example: VLOOKUP vs. INDEX MATCH

- VLOOKUP is essentially a special case of INDEX MATCH:
  - VLOOKUP(lookup_value, table_array, col_index_num, FALSE)

  is the same as
  - INDEX(table_array, MATCH(lookup_value, **lookup_array**, 0), col_index_num)
- If we wanted INDEX MATCH to do the same thing as VLOOKUP, ***lookup_array*** would simply be the first column of *table_array*.
- We can see INDEX MATCH gives much more freedom:
  - We can select any **lookup_array** we want
  - We can even replace col_index_num with another MATCH statement!

OFFSET(reference, rows, cols, [height], [width])

	A	B	C	D	E	F	G
1	A1	B1	C1	D1		**Formula**	**Output**
2	A2	B2	C2	D2		=OFFSET($A$1,2,1)	B3
3	A3	B3	C3	D3		=OFFSET($A$1,1,3)	D2
4	A4	B4	C4	D4		=OFFSET($A$1,2,0)	A3
5						=OFFSET($B$2,-1,0)	B1
6						=OFFSET($C$3,1,-2)	A4

- Returns a reference to a range a specified number of **rows** and **cols** away from an “anchor” cell called **reference.**

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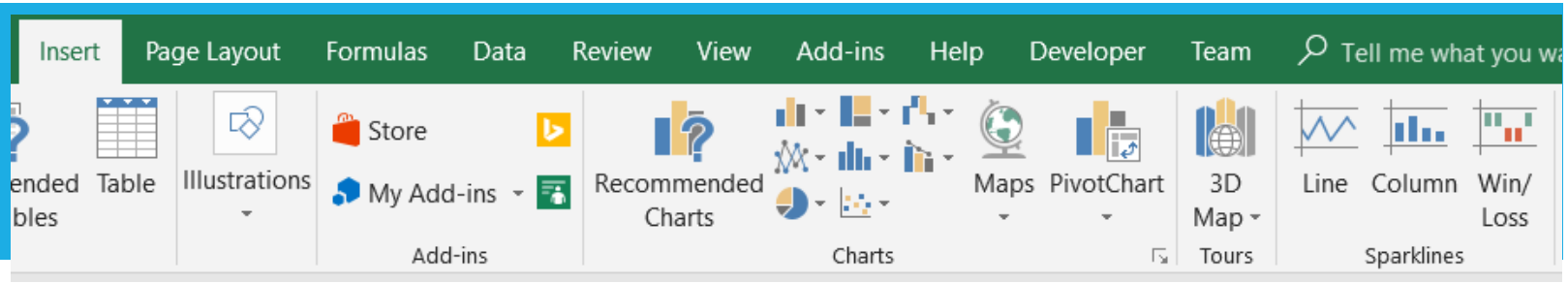
Sparklines



- Useful tool for quickly visualizing a lot of data without having to go through the trouble of making a chart
- For example, summarizing data in each row and each column:

	A	B	C	D	E
1	7	9	4	7	
2	6	8	10	7	
3	9	9	5	4	
4	9	2	4	6	
5	1	7	1	4	
6					

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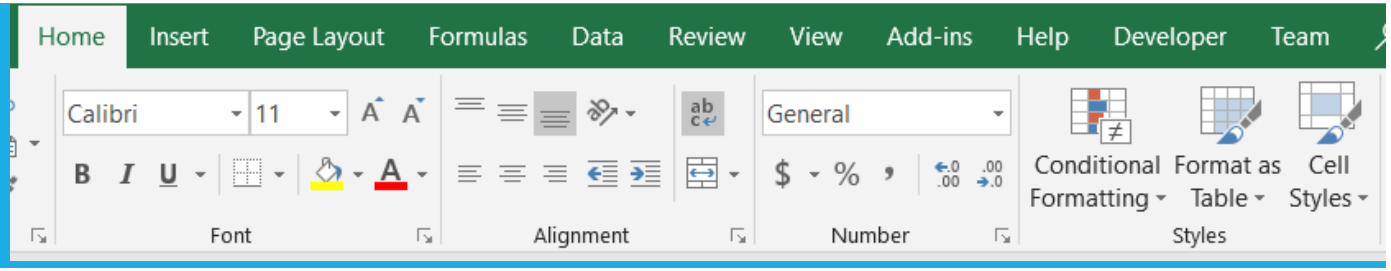
Conditional Formatting



- Another quick way to format cells and visualize the data within

	A	B	C	D
1	7	9	4	7
2	6	8	10	7
3	9	9	5	4
4	9	2	4	6
5	1	7	1	4
6				
7	7	9	4	7
8	6	8	10	7
9	9	9	5	4
10	9	2	4	6
11	1	7	1	4

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SUMPRODUCT(array1, [array2], [array3], …)

	A	B	C	D	E	F
1	Value (1)	Weight (2)	**Product (1) x (2)**		**Formula**	**Output**
2	58	-0.15	-8.7		=SUMPRODUCT(A2:A8,B2:B8)	67.3
3	8	-0.05	-0.4			
4	75	0.1	7.5			
5	16	0.2	3.2			
6	32	0.25	8			
7	78	0.3	23.4			
8	98	0.35	34.3			
9		**Sum:**	67.3			

- Multiplies the corresponding values in the **array**s (all of which are the same dimension), then adds them together

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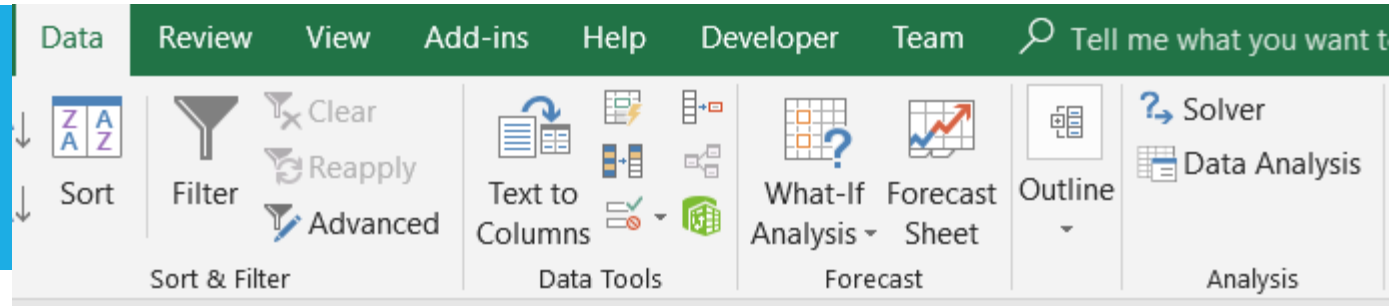
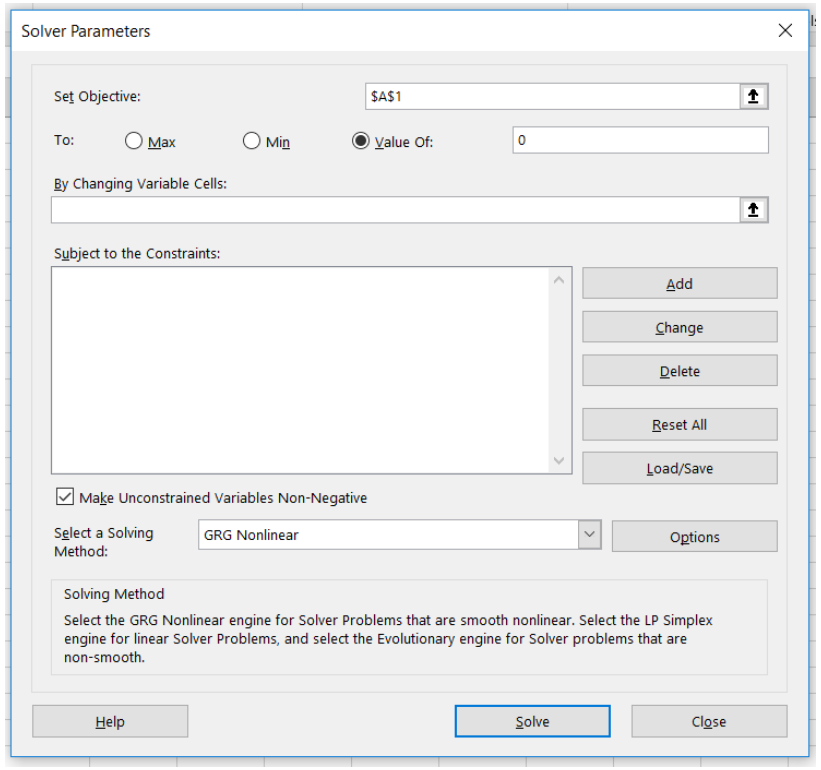
Solver



- https://support.office.com/en-us/article/load-the-solver-add-in-in-excel-612926fc-d53b-46b4-872c-e24772f078ca
- A more powerful version of GoalSeek that can optimize (min/max) with constraints



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APPENDIX

Background on the problem and mathematical justification

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Background

- You are a reserving actuary for Bruin Auto Liability Insurance, LLC, a Los Angeles based company insuring personal automobile casualty losses in Southern California.
- BAL's reserving practice is quite limited, and you have been asked to create a basic model of loss development to evaluate the state of the company’s reserves.

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Background

- It is January 1st, 2019. The reserving team in the actuarial department has set aside a pure IBNR reserve of $7M to pay for losses occurring before 2019 reported in 2019.
- It is your task to determine whether this reserve is too low, appropriate, or too high. If the current reserve is not representative of what BAL expects to pay out, suggest a new reserve level.
- During your analysis, you may ignore claims occurring in 2019, as these trends will be analyzed by a different team.
- If there are significant differences in claim development by county, report this to management as well.

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Background

- You have also been presented with an excerpt of the company's income statement for 2018. Analyze the effects changing reserves will have on the company's financials (assuming an 85% loss ratio), and suggest a target expense ratio to maintain the overall profit margin.
- If this expense ratio is not feasible, what rate of return must BAL receive on its investments to maintain the overall profit margin, assuming a reasonable expense ratio?

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Development Triangles: The Idea

For simplicity, assume this is 0.

AY \ Report	2015	2016	2017	2018	2019
2015	149	171	55	11	0
2016	0	184	182	66	??
2017	0	0	195	209	??
2018	0	0	0	218	??

- Key idea: Not all accidents that occur in a year are reported in that year.
- For instance, only $149 of losses occurring in 2015 were reported in 2015.
  - $171 was reported in 2016, $55 in 2017, and $11 was reported in 2018.
- We want to estimate, for instance, how much we will pay for losses from 2016.

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Development Triangles: Using lags instead of years

Lag / AY	1	2	3	4
2015	149	171	55	11
2016	184	182	66	
2017	195	209		
2018	218			

- It doesn't matter to us *in what year* we pay.
- Rather, we care about *how many years after the loss* we pay. This allows us to combine data meaningfully.
- $171 of losses from 2015 were reported after 1 year, but before the end of 2 years (i.e., 2016).
  - This is $182 for the 2016 2-year lag and $209 for the 2017 2-year lag.

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Development Triangles: Cumulative paid amounts

AY \ Lag	1	2	3	4
2015	149	320	375	386
2016	184	366	432	
2017	195	404		
2018	218			

- Next, we convert our amounts to cumulative amounts.
- This allows us to see the proportional increase over lags.

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Development Triangles: Loss Development Factors

AY \ Lag	1		2		3		4
2015	149	x 2.15 →	320	x 1.17 →	375	x 1.03 →	386
2016	184	x 1.99 →	366	x 1.18 →	432		
2017	195	x 2.07 →	404				
2018	218						

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Development Triangles: Loss Development Factors

AY \ Lag	1 – 2	2 - 3	3 - 4
2015	2.15	1.17	1.03
2016	1.99	1.18	
2017	2.07		

- These multiplicative factors are called **loss development factors.**
- From this, we can take weighted average, simple average, etc. to determine what factor we want to pick.

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Development Triangles: Loss Development Factors

AY \ Lag	1 – 2	2 - 3	3 - 4
2015	2.15	1.17	1.03
2016	1.99	1.18	
2017	2.07		
Simple Average	2.07	1.18	1.03

- For simplicity, suppose we use the simple average.
- This means between the first and second year, we can expect the cumulative paid amount to be multiplied by 2.07.

Development Triangles: Filling in our triangle

AY \ Lag	1	2	3	4
2015	149	320	375	386
2016	184	366	432	445
2017	195	404	475	489
2018	218	451	531	546

x 2.07 → (2018: 218 → 451)

x 1.18 → (2017: 404 → 475; 2018: 451 → 531)

x 1.03 → (2016: 432 → 445; 2017: 475 → 489; 2018: 531 → 546)

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Development Triangles: Cumulative Development Factors

Lag	1 – 2	2 - 3	3 - 4
Simple Average	2.07	1.18	1.03
CDF	2.51 (2.07 x 1.21)	1.21 (1.18 x 1.03)	1.03

- Instead of calculating each cell, we can jump straight to the end with cumulative development factors.

Development Triangles: Cumulative Development Factors

AY \ Lag	1	2	3	4
2015	149	320	375	386
2016	184	366	432	445
2017	195	404		489
2018	218			546

x 1.03 (2016: 432 → 445)

x 1.21 (2017: 404 → 489)

x 2.51 (2018: 218 → 546)

Development Triangles: Cumulative Development Factors

AY \ Lag	1	2	3	4
2015	149	320	375	386
2016	184	366	432	445
2017	195	404		489
2018	218			546

- The final column (in red) indicates how much we expect to pay, in total, from losses occurring in each of the accident years.
- Our IBNR reserve is what we expect to pay less what we already paid.