

What-If Analysis

What-If Analysis in **Excel** allows you to try out different values (scenarios) for formulas. The following example helps you master what-if analysis quickly and easily.

Assume you own a book store and have 100 books in storage. You sell a certain % for the highest price of \$50 and a certain % for the lower price of \$20.

	A	B	C	D	E
1	Book Store				
2					
3		total number of books	% sold for the highest price		
4		100	60%		
5					
6			number of books	unit profit	
7		highest price	60	\$50	
8		lower price	40	\$20	
9					
10			total profit	\$3,800	
11					

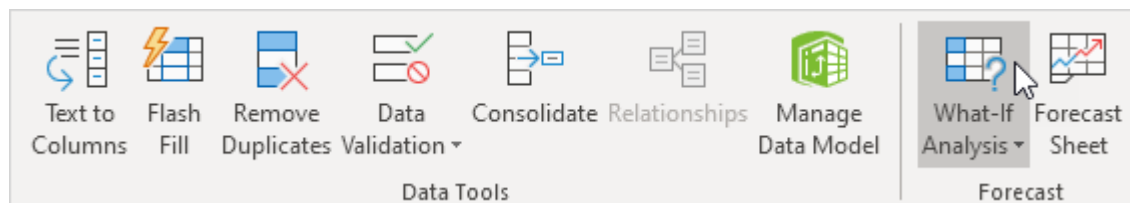
If you sell 60% for the highest price, cell D10 calculates a total profit of $60 * \$50 + 40 * \$20 = \$3800$.

Create Different Scenarios

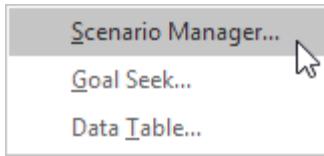
But what if you sell 70% for the highest price? And what if you sell 80% for the highest price? Or 90%, or even 100%? Each different percentage is a different **scenario**. You can use the Scenario Manager to create these scenarios.

Note: You can simply type in a different percentage into cell C4 to see the corresponding result of a scenario in cell D10. However, what-if analysis enables you to easily compare the results of different scenarios.

1. On the Data tab, in the Forecast group, click What-If Analysis.

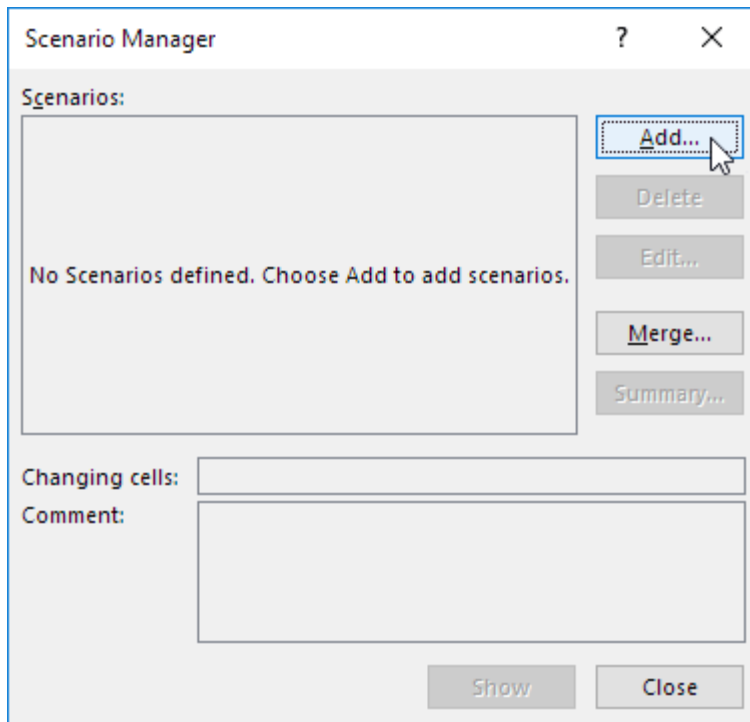


2. Click Scenario Manager.

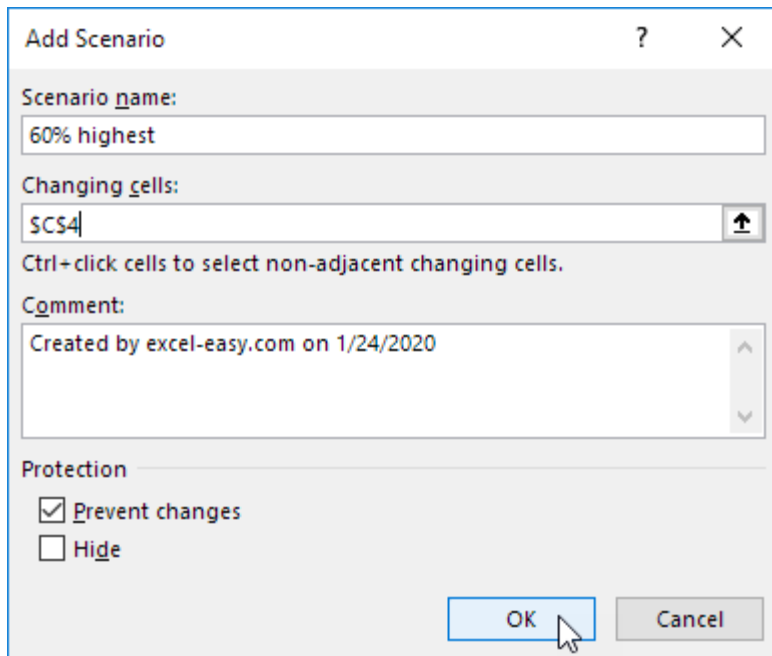


The Scenario Manager dialog box appears.

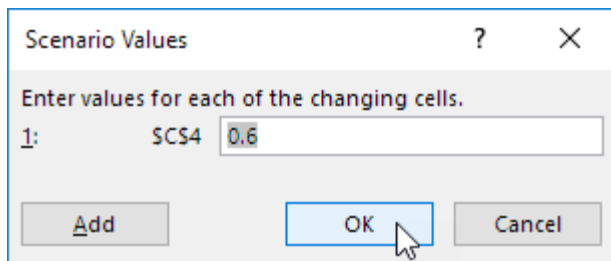
3. Add a scenario by clicking on Add.



4. Type a name (60% highest), select cell C4 (% sold for the highest price) for the Changing cells and click on OK.

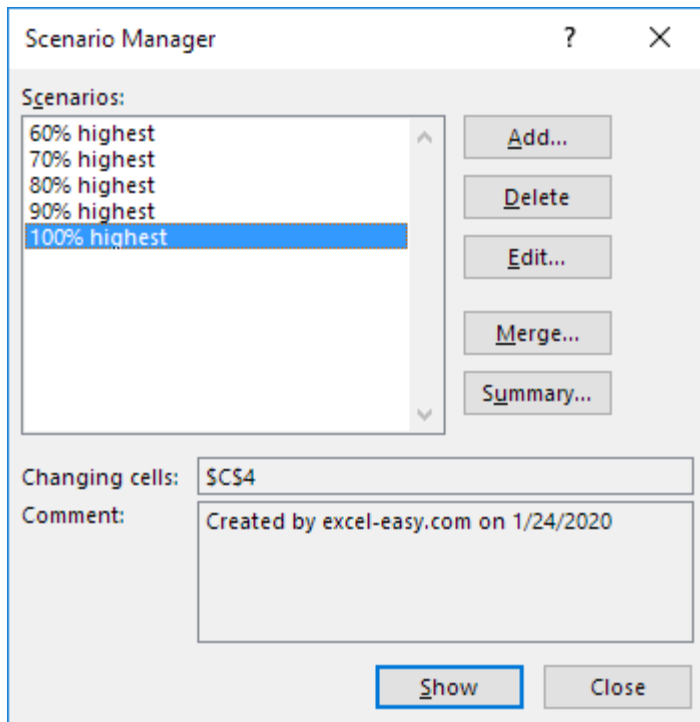


5. Enter the corresponding value 0.6 and click on OK again.



6. Next, add 4 other scenarios (70%, 80%, 90% and 100%).

Finally, your Scenario Manager should be consistent with the picture below:

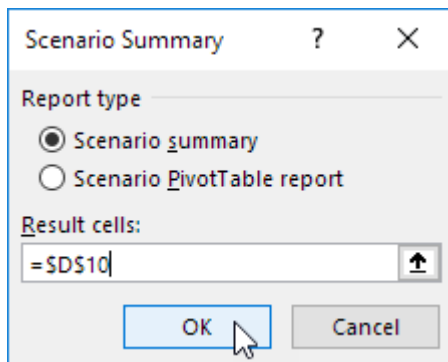


Note: to see the result of a scenario, select the scenario and click on the Show button. Excel will change the value of cell C4 accordingly for you to see the corresponding result on the sheet.

Scenario Summary

To easily compare the results of these scenarios, execute the following steps.

1. Click the Summary button in the Scenario Manager.
2. Next, select cell D10 (total profit) for the result cell and click on OK.



Result:

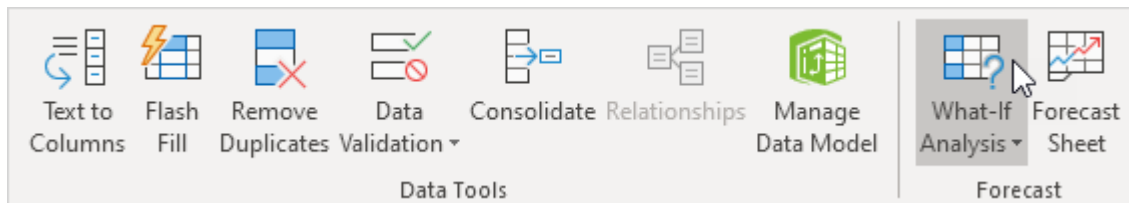
Scenario Summary						
Current Values:	60% highest	70% highest	80% highest	90% highest	100% highest	
Changing Cells:						
\$C\$4	60%	60%	70%	80%	90%	100%
Result Cells:						
\$D\$10	\$3,800	\$3,800	\$4,100	\$4,400	\$4,700	\$5,000
Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.						

Conclusion: if you sell 70% for the highest price, you obtain a total profit of \$4100, if you sell 80% for the highest price, you obtain a total profit of \$4400, etc. That's how easy what-if analysis in Excel can be :-).

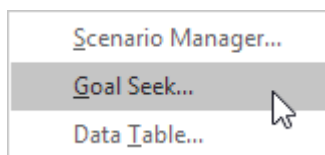
Goal Seek

What if you want to know how many books you need to sell for the highest price, to obtain a total profit of exactly \$4700? You can use **Excel's Goal Seek** feature to find the answer.

1. On the Data tab, in the Forecast group, click What-If Analysis.



2. Click Goal Seek.



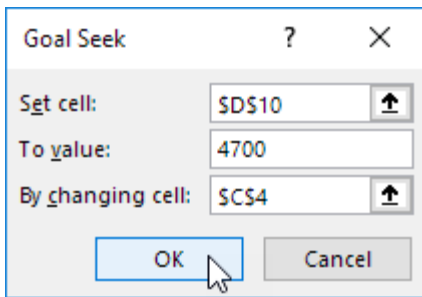
The Goal Seek dialog box appears.

3. Select cell D10.

4. Click in the 'To value' box and type 4700.

5. Click in the 'By changing cell' box and select cell C4.

6. Click OK.



Result. You need to sell 90% of the books for the highest price to obtain a total profit of exactly \$4700.

	A	B	C	D	E
1	Book Store				
2					
3		total number of books	% sold for the highest price		
4		100	90%		
5					
6			number of books	unit profit	
7		highest price	90	\$50	
8		lower price	10	\$20	
9					
10			total profit	\$4,700	
11					

More on Goal Seek

If you know the result you want from a formula, use **Goal Seek** in **Excel** to find the input value that produces this formula result. **It's like working backwards from a solution to the problem (input).**

Goal Seek Example 1

Use Goal Seek in Excel to find the grade on the fourth exam that produces a final grade of 70.

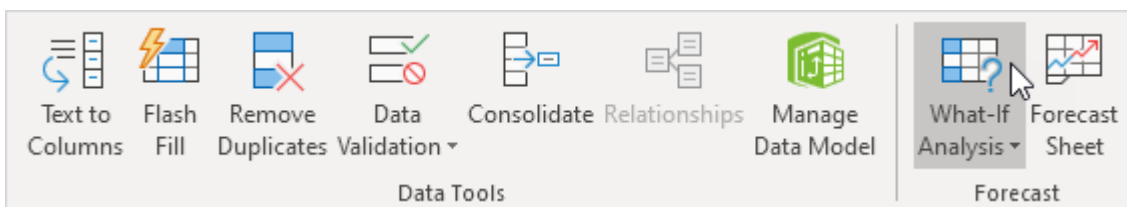
1. The formula in cell B7 calculates the final grade.

	A	B	C	D	E	F	G	H	I
1	Exam	Grade							
2	Exam 1	50							
3	Exam 2	80							
4	Exam 3	60							
5	Exam 4								
6									
7	Final Grade	63.33333							
8									

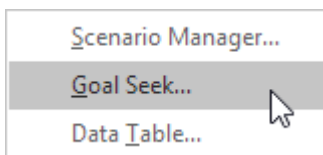
2. The grade on the fourth exam in cell B5 is the input cell.

	A	B	C	D	E	F	G	H	I
1	Exam	Grade							
2	Exam 1	50							
3	Exam 2	80							
4	Exam 3	60							
5	Exam 4								
6									
7	Final Grade	63.33333							
8									

3. On the Data tab, in the Forecast group, click What-If Analysis.



4. Click Goal Seek.



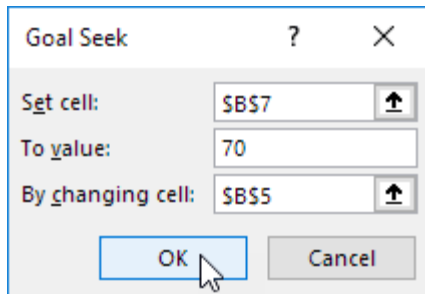
The Goal Seek dialog box appears.

5. Select cell B7.

6. Click in the 'To value' box and type 70.

7. Click in the 'By changing cell' box and select cell B5.

8. Click OK.



Result. A grade of 90 on the fourth exam produces a final grade of 70.

	A	B	C	D	E	F	G	H	I
1	Exam	Grade							
2	Exam 1	50							
3	Exam 2	80							
4	Exam 3	60							
5	Exam 4	90							
6									
7	Final Grade	70							
8									

Goal Seek Example 2

Use Goal Seek in Excel to find the loan amount that produces a monthly payment of \$1500.

1. The formula in cell B5 calculates the monthly payment.

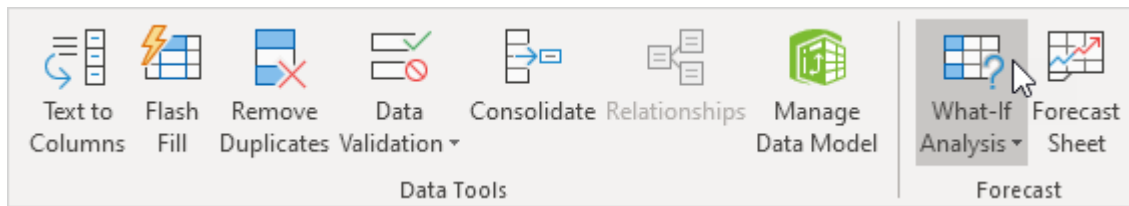
	A	B	C	D	E	F	G	H
1	Annual Rate	6%						
2	Years	30						
3	Loan Amount	\$300,000						
4								
5	Monthly Payment	(\$1,798.65)						
6								

Explanation: the PMT function calculates the payment for a loan. If you've never heard of this function before, that's OK. The higher the loan amount, the higher the monthly payment. Assume, you can only afford \$1500 a month. What is your maximum loan amount?

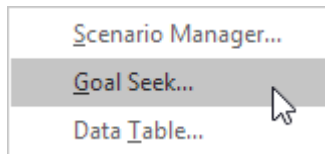
2. The loan amount in cell B3 is the input cell.

	A	B	C	D	E	F	G	H
1	Annual Rate	6%						
2	Years	30						
3	Loan Amount	\$300,000						
4								
5	Monthly Payment	(\$1,798.65)						
6								

3. On the Data tab, in the Forecast group, click What-If Analysis.



4. Click Goal Seek.



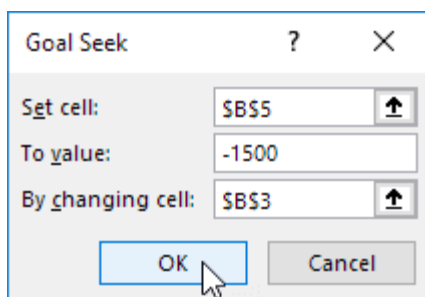
The Goal Seek dialog box appears.

5. Select cell B5.

6. Click in the 'To value' box and type -1500 (negative, you are paying out money).

7. Click in the 'By changing cell' box and select cell B3.

8. Click OK.



Result. A loan amount of \$250,187 produces a monthly payment of \$1500.

B3		250187.421588503						
	A	B	C	D	E	F	G	H
1	Annual Rate	6%						
2	Years	30						
3	Loan Amount	\$250,187						
4								
5	Monthly Payment	(\$1,500.00)						
6								

Goal Seek Precision

Goal seek returns approximate solutions. You can change the iteration settings in Excel to find a more precise solution.

1. The formula in cell B1 calculates the square of the value in cell A1.

B1		=A1^2							
	A	B	C	D	E	F	G	H	I
1	2	4							
2									

2. Use goal seek to find the input value that produces a formula result of 25.

Goal Seek ? X

Set cell:

To value:

By changing cell:

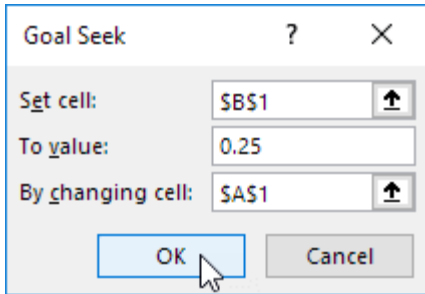
Result. Excel returns an approximate solution.

A1		4.99999252400127							
	A	B	C	D	E	F	G	H	I
1	4.999993	24.99993							
2									

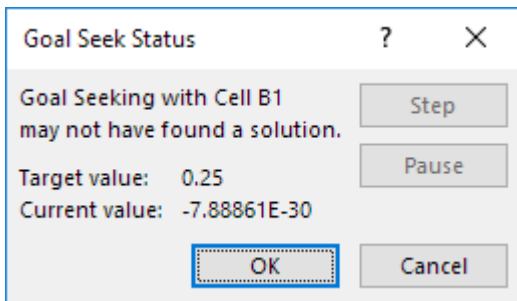
3. On the File tab, click Options, Formulas.

4. Under Calculation options, decrease the Maximum Change value by inserting some zeros. The default value is 0.001.

2. Use Goal Seek to find the input value that produces a formula result of +0.25.



Result. Excel can't find a solution.



3. Click Cancel.

4. Start with an input value greater than 8.

		B1		=1/(A1-8)					
	A	B	C	D	E	F	G	H	I
1	8.01	100							
2									

5. Use Goal Seek again. Excel finds a solution.

		A1		11.9999999920539					
	A	B	C	D	E	F	G	H	I
1	12	0.25							
2									

Explanation: $y = 1 / (x - 8)$ is discontinuous at $x = 8$ (dividing by 0 is not possible). In this example, Goal seek cannot reach one side of the x-axis ($x > 8$) if it starts on the other side of the x-axis ($x < 8$) or vice versa.

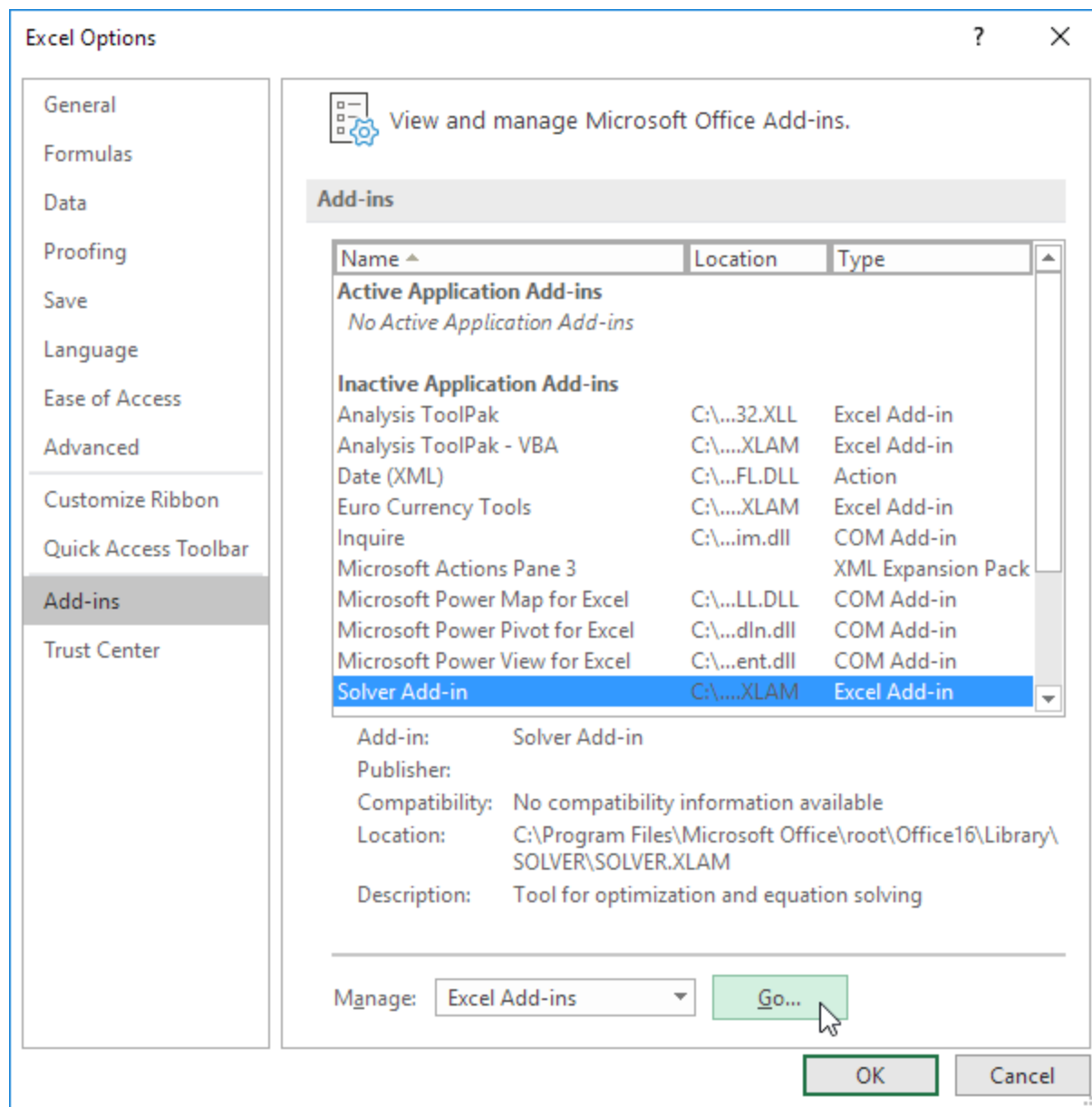
Solver

Excel includes a tool called **solver** that uses techniques from the operations research to find optimal solutions for all kind of decision problems.

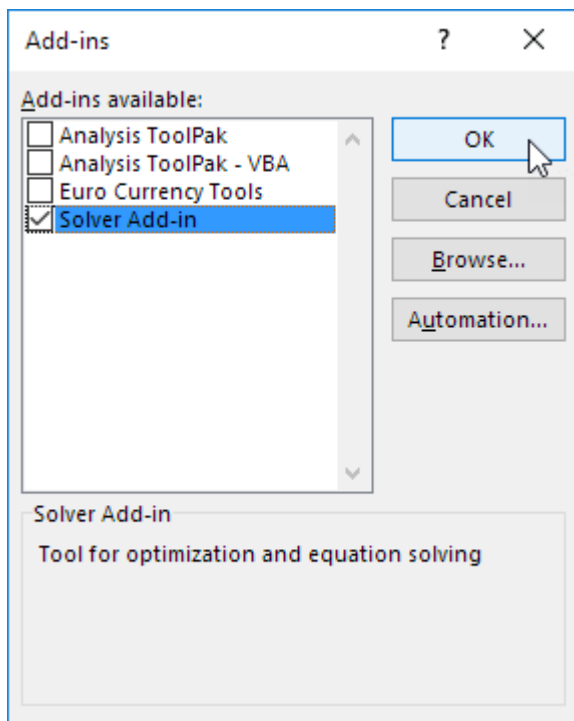
Load the Solver Add-in

To load the solver add-in, execute the following steps.

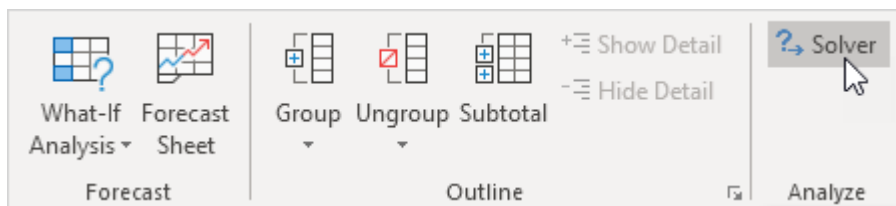
1. On the File tab, click Options.
2. Under Add-ins, select Solver Add-in and click on the Go button.



3. Check Solver Add-in and click OK.



4. You can find the Solver on the Data tab, in the Analyze group.



Formulate the Model

The **model** we are going to **solve** looks as follows in Excel.

	A	B	C	D	E	F	G	H	I	J
1	Cycle Trader									
2										
3			Bicycles	Mopeds	Child Seats					
4		Unit Profit	100	300	50					
5							Resources		Resources	
6							Used		Available	
7		Capital	300	1200	120		0	≤	93000	
8		Storage	0.5	1	0.5		0	≤	101	
9										
10										
11			Bicycles	Mopeds	Child Seats				Total Profit	
12		Order Size	0	0	0				0	
13										

1. To formulate this **linear programming model**, answer the following three questions.

a. What are the decisions to be made? For this problem, we need Excel to find out how much to order of each product (bicycles, mopeds and child seats).

b. What are the constraints on these decisions? The constraints here are that the amount of capital and storage used by the products cannot exceed the limited amount of capital and storage (resources) available. For example, each bicycle uses 300 units of capital and 0.5 unit of storage.

c. What is the overall measure of performance for these decisions? The overall measure of performance is the total profit of the three products, so the objective is to maximize this quantity.

2. To make the model easier to understand, create the following named ranges.

Range Name	Cells
UnitProfit	C4:E4
OrderSize	C12:E12
ResourcesUsed	G7:G8
ResourcesAvailable	I7:I8
TotalProfit	I12

3. Insert the following three SUMPRODUCT functions.

E	F	G	H	I	J
Child Seats					
50					
		Resources		Resources	
		Used		Available	
120		=SUMPRODUCT(C7:E7,OrderSize)	≤	93000	
0.5		=SUMPRODUCT(C8:E8,OrderSize)	≤	101	
Child Seats				Total Profit	
0				=SUMPRODUCT(UnitProfit,OrderSize)	

Explanation: The amount of capital used equals the sumproduct of the range C7:E7 and OrderSize. The amount of storage used equals the sumproduct of the range C8:E8 and OrderSize. Total Profit equals the sumproduct of UnitProfit and OrderSize.

Trial and Error

With this formulation, it becomes easy to analyze any trial solution.

For example, if we order 20 bicycles, 40 mopeds and 100 child seats, the total amount of resources used does not exceed the amount of resources available. This solution has a total profit of 19000.

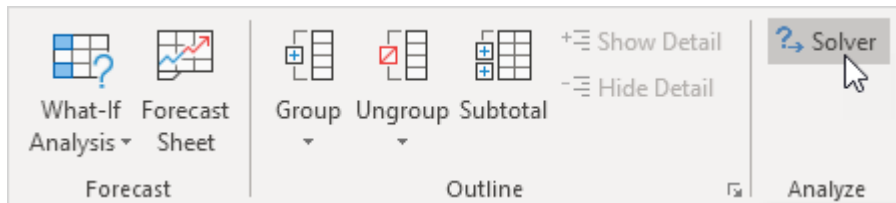
	A	B	C	D	E	F	G	H	I	J
1	Cycle Trader									
2										
3			Bicycles	Mopeds	Child Seats					
4		Unit Profit	100	300	50					
5							Resources		Resources	
6							Used		Available	
7		Capital	300	1200	120		66000	≤	93000	
8		Storage	0.5	1	0.5		100	≤	101	
9										
10										
11			Bicycles	Mopeds	Child Seats				Total Profit	
12		Order Size	20	40	100				19000	
13										

It is not necessary to use trial and error. We shall describe next how the Excel Solver can be used to quickly find the optimal solution.

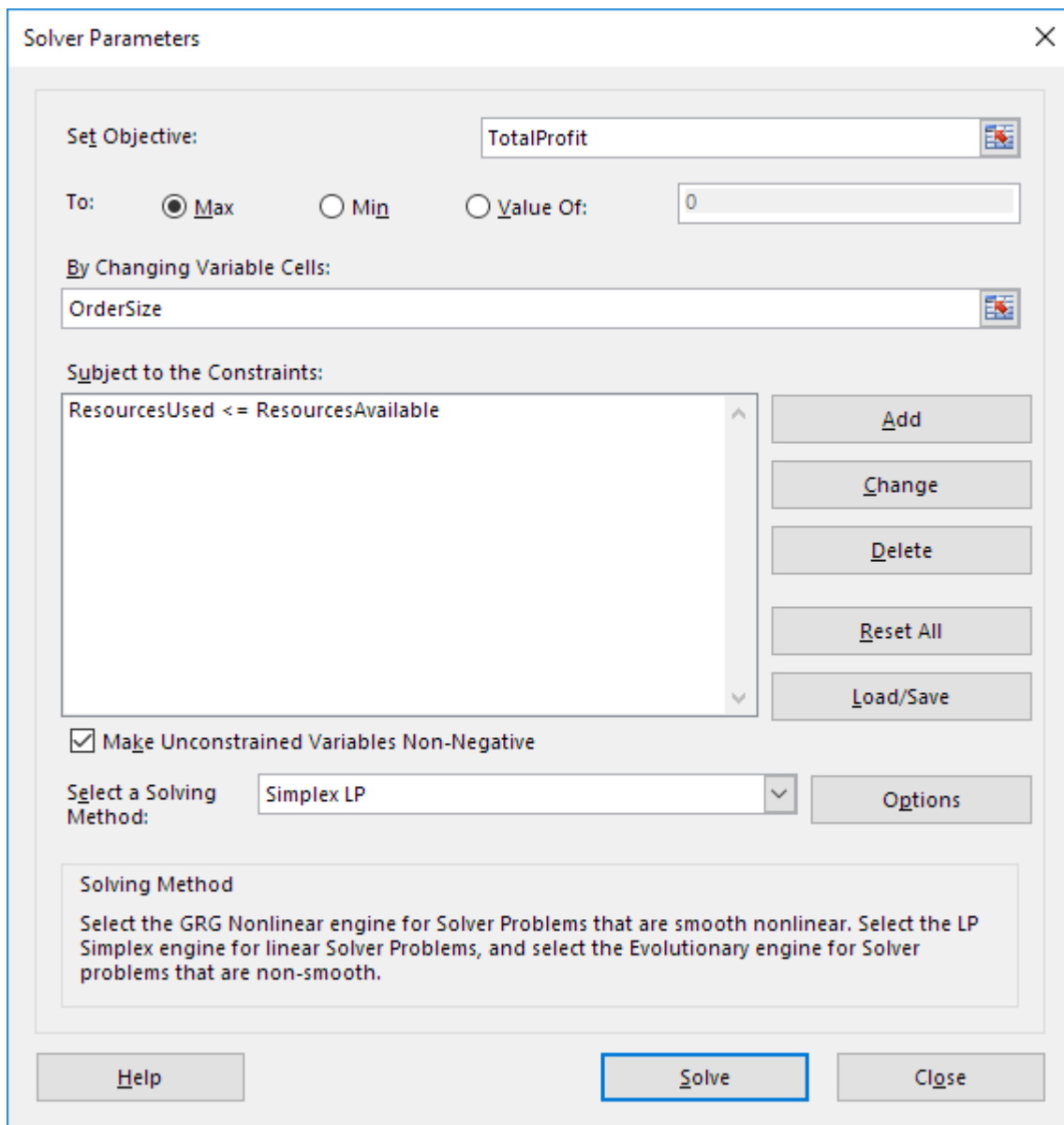
Solve the Model

To find the **optimal solution**, execute the following steps.

1. On the Data tab, in the Analyze group, click **Solver**.

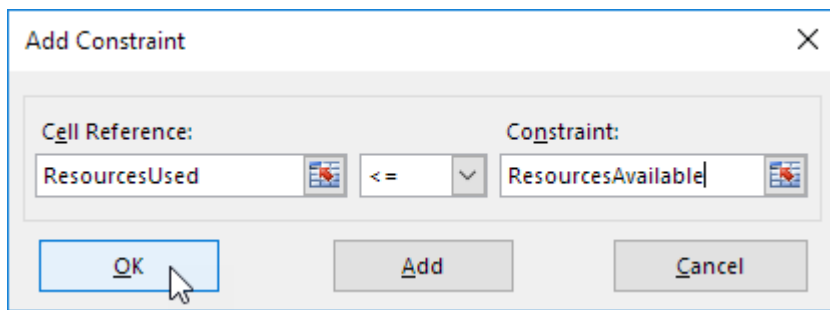


Enter the solver parameters (read on). The result should be consistent with the picture below.



You have the choice of typing the range names or clicking on the cells in the spreadsheet.

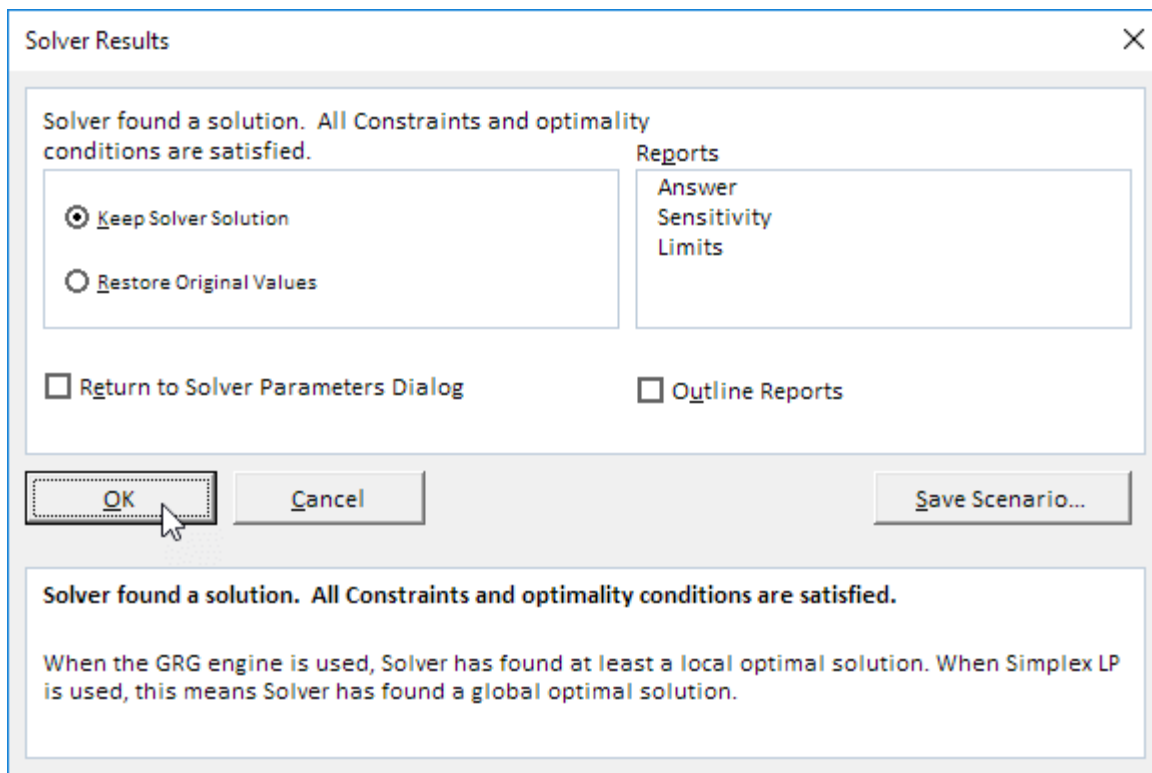
2. Enter TotalProfit for the Objective.
3. Click Max.
4. Enter OrderSize for the Changing Variable Cells.
5. Click Add to enter the following constraint.



6. Check 'Make Unconstrained Variables Non-Negative' and select 'Simplex LP'.

7. Finally, click Solve.

Result:



The optimal solution:

	A	B	C	D	E	F	G	H	I	J
1	Cycle Trader									
2										
3			Bicycles	Mopeds	Child Seats					
4		Unit Profit	100	300	50					
5							Resources		Resources	
6							Used		Available	
7		Capital	300	1200	120		93000	≤	93000	
8		Storage	0.5	1	0.5		101	≤	101	
9										
10										
11			Bicycles	Mopeds	Child Seats				Total Profit	
12		Order Size	94	54	0				25600	
13										

Conclusion: it is optimal to order 94 bicycles and 54 mopeds. This solution gives the maximum profit of 25600. This solution uses all the resources available.