

## MS Excel

### Topics - What If Analysis

#### Data Pipeline

While solving any computational problem in Excel, we usually write formulas in some cells in such a way that the formula refers to some other cells for getting the required values for computation. The referenced cells may again refer to some other cells or may contain values of their own. This kind of chaining of linked cells forms a kind of data pipeline where cells at one end acts as input which take their values from the user while the cell at the other end acts as output. If some values are entered in input cells and excel computes the new results in the output cell after computing the results for the intermediate cells of the pipeline. If we change the values in the input cells, the value in the output cell also changes.

The following sheet shows few cases of input-output relationships. For case 1 one cell B2 acts as input cells while cells B3 acts as output cell; for case 2, two cells B6 and B7 acts as input cells while cell B8 acts as output cell; for case 3, three cells B11, B12 and B13 act as input cells while cell B14 act as the output cell and finally for case 4, an indirectly referenced cell D2 acts as input while D8 acts as the output cell.

	A	B	C	D
1	<b>Case 1</b>		<b>Case 3</b>	
2	Radius of a Circle	10	Basic Salary	100000
3	Area of the Circle	=2*pi()*B1	HRA	200
4			DA	=C2*10%
5	<b>Case 2</b>		Gross Salary	=C4+C3+C2
6	Length of a rectangle	10	Tax	=C5*20%
7	Breadth of the rectangle	20	Net Salary	=C5 - C6
8	Area of the rectangle	=B6*B7		
9				
10	<b>Case 4</b>			
11	Cost of a product	200		
12	Selling price of the product	400		
13	Qty of product sold	10		
14	Profit	=(B12-B11)*B13		

\*Yellow cells acting as inputs and green cells acting as outputs

In such kind of input output relationship between different cells of data pipelines, a user may also need answer(s) to the following kind of questions.

1. **Output known - input unknown:** What can be the values of input cells if the expected target value of output cell is known? – For example, in case 1 of the following diagram, cell B2 is input cell and B3 acts as output cell and a user may want to know - what can be the value of radius of a circle whose area is 100?
2. **Input known - output unknown:** What will be the values of output cell if many values of input cells are known? – For example, what will the values of area of two rectangles whose lengths and breadths are (100, 200) and (50, 70)?

#### What-If Analysis

Excel provides a “What-If analysis” toolkit for finding the answers to above given kind of questions. There are three tools in the toolkit – 1) *Goal Seek*, 2) *Data Table* and 3) *Scenario Manager*. Each tool is used in a different situation. Goal seek helps in finding answer to questions of first type where output is known but only one of the inputs is to be found. Data Table and Scenario Manager help in finding answers to questions of second type in which some of the inputs (one, two or more two inputs) are known but output is to be found. **Note:** It is important to note that there is no tool in Excel which can find values of more than one input cells for a given output because there may be many values of input cells that can produce the same output.

Now let us learn the exact procedure of different tools of What-If Analysis toolkit.

### Goal Seek

**Description:** As represented in the following diagram, Goal seek helps in finding the value of one of the input cells for a known expected value of the output cell.



For example in the following spreadsheet, goal seek may be used to find the radius of a circle (in input cell) if the area of the circle (in output cell) is already known as per the following spreadsheet.

	A	B
1	<b>Case1</b>	
2	Radius of a Circle	??
3	Area of the Circle	=2*pi()*B2
4		

Similarly in the following example, a user can find the value of length of a rectangle whose area and breadth are already known.

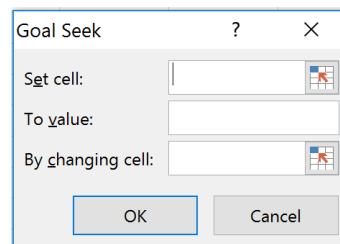
	A	B
5	<b>Case2</b>	
6	Length of a rectangle	??
7	Breadth of the rectangle	20
8	Area of the rectangle	=B6*B7

The goal seek tool uses an iterative process in the background in which Excel starts by substituting some arbitrary value in the input cell and checks the desired (known) value is produced in the output cell. If not, it increments the value by some small value then substitute the new value in input cell and checks again. This process is repeated until a value of input cell is found or else the number of permitted iterations (100) are exhausted. If the process is terminated because all the iterations have been exhausted, the value found is not the correct answer.

The limitation of Goal Seek tool is that it can find out the value of input cell only for one given value of the output cell at a time. If a user wants to find out input values corresponding to many values of output cell, the goal seek should be used again and again.

The following procedure is used to apply goal seek.

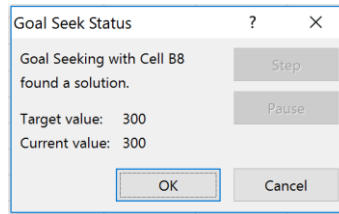
**Step 1:** Open Data > What-If Analysis > Goal Seek. This will show the following type of popup screen.



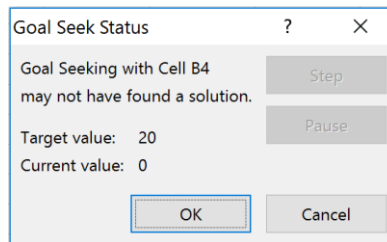
The popup screen provides three text boxes – 1) Set Cell, 2) To value and 3) By changing cell. The place for “Set cell” is for giving the address of output cell. The place for “To value” is for giving the desired known/expected value of output cell and “By changing cell” is for giving the address of the input cell. In other words, these three text boxes define the input cell, output cell and the known output value.

**Step 2:** Provide information for all the three text boxes

**Step 3:** If the Goal seek is able to find the required input value, it will show a Goal Seek Status dialogue box of the following type which tells that “found a solution” and target value is the same as the current value.



If the required input value could not be found, it shows the Goal Seek Status dialogue box of the following type which tells that Goal Seek may not have found a solution and the target value is different than the current value.



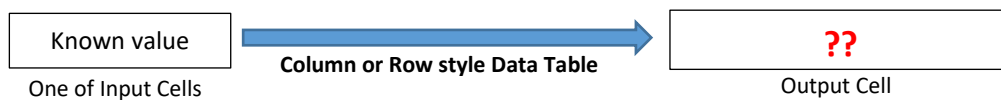
*Example 1:* - Let us assume that in case 1 given above, we want to find out the radius of the circle (input cell) whose area (output cell) is 20. Here we supply cell B3, 20 and B2 for the text boxes against “Set cell”, “To value” and “By changing cell” respectively. After clicking on Ok, we get the Goal Seek status which has found the solution. And the input cell B2 is substituted with the value of 3.18309.

*Example 2:* - Let us assume that in case 2 given above, we want to find out the length of a rectangle (input cell) whose breadth (another input cell) is fixed at 15 and whose area (output cell) is desired to become 200. Here we supply cell B8, 300 and B6 for the text boxes against “Set cell”, “To value” and “By changing cell” respectively. After clicking on Ok, we get the Goal Seek status which has found the solution. And the input cell B2 is substituted with the value of 20.

### Data Table

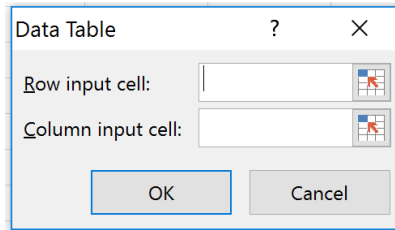
Data Table finds the value of an output cell for known values of one or at the most two of the input cells. Unlike Goal seek, it can find output values against a list of input values in one go, i.e., a Data Table can generate outputs for multiple inputs. Data Table can be used in two ways – 1) as one dimensional data table or 2) as two dimensional data table. The data table works by substituting the input cells with different values and generates corresponding output values.

**One Dimensional Data Table** – As shown in the following figure, when the value of only one input cell is to be substituted, one dimensional data table is used. A one dimensional data table can take the shape of a column or row. If the given values of input cell are arranged in a row fashion, row style data table is used, but if the given values of the input cell are arranged in a column fashion, column style data table is used.



Procedure for creating a row style data table is as follows:

- Step 1:* Prepare the solution for any one value of input cell whose value is to be substituted.
- Step 2:* Write all the known substitution values for the one of the input cells in one row leaving the first cell blank in the beginning.
- Step 3:* In the second row, fill the first cell with the formula in the output cell (one can also write the formula which equates the first cell to the output cell).
- Step 4:* Select the entire table of these two rows and click Data > What-If Analysis > Data Table. This will show the following type of dialogue box.



Although, the dialogue box provides two text boxes, only the first text box belonging to “Row input cell” is to be used.

*Step 5:* In the text box against “Row input cells”, enter the cell address on the input cell whose value is to be substituted by the values in the Data table.

*Step 6:* Click Ok. This provides the computed values of output cell under each of the row values.

**Example:** Prepare an excel sheet that computes the compound amount on a principal amount of Rs 100000 at 12% rate of interest per year compounded annually for the durations of 1, 2, 5, 7 and 10 years using a row based data table.

**Solution:**

*Step 1:* Solve the problem for one set of input values.

*Step 2:* Write different input values of for duration in a row in cells B7 to F7

*Step 3:* Fill the cell A8 with formula =B5

*Step 4:* Select the entire table from A7 to F8. Click on Data Table

*Step 5:* Enter the input cell as B4 in the text box for Row input cell.

*Step 6:* Click Ok

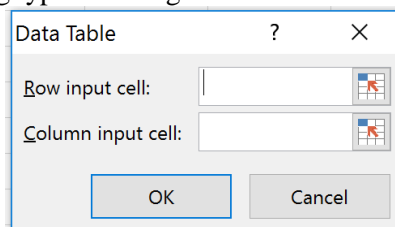
Procedure for creating a column style data table is as follows:

*Step 1:* Prepare the solution for any one value of input cell whose value is to be substituted.

*Step 2:* Write all the known substitution values for the one of the input cells in one column leaving the first cell blank in the beginning.

*Step 3:* In the second column, fill the first cell with the formula in the output cell (one can also write the formula which equates the first cell to the output cell).

*Step 4:* Select the entire table of these two columns and click Data > What-If Analysis > Data Table. This will show the following type of dialogue box.



Although, the dialogue box provides two text boxes, only the first text box belonging to “Column input cell” is to be used.

*Step 5:* In the text box against “Column input cells”, enter the cell address on the input cell whose value is to be substituted by the values in the Data table.

*Step 6:* Click Ok.

This provides the computed values of output cell under each of the row values.

**Example:** Prepare an excel sheet that computes the compound amount on a principal amount of Rs 100000 at 12% rate of interest per year compounded annually for the durations of 1, 2, 5, 7 and 10 years using a column based data table.

**Solution:** Do the following steps

*Step 1:* Solve the problem for one set of input values.

*Step 2:* Write different input values of for duration in a row in cells A9 to A13

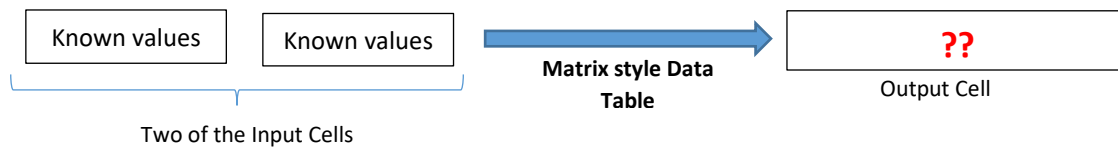
*Step 3:* Fill the cell B8 with formula =B5

*Step 4:* Select the entire table from A8 to B13. Click on Data Table

*Step 5:* Enter the input cell as B4 in the text box for Column input cell.

*Step 6:* Click Ok

**Two Dimensional Data Table** – As shown in the following figure, when the values of only two of the input cells are chosen to be substituted, a two dimensional data table is used. Input cells other than the two are kept constant with some fixed values in them.



A two dimensional data table takes the shape of a matrix in which the first row contains the substitution values for one input cell and first column contains the substitution values for the second cell. The two dimensional data table prepares all possible combinations of input values of two cells and generates output for each of those combinations and puts the generated value at the cross section of corresponding row and column.

Procedure for creating a two dimensional table is as follow:

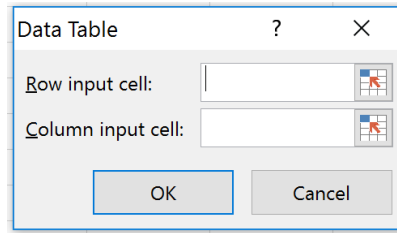
*Step 1:* Prepare the solution for any arbitrary values of input cells whose values are to be substituted.

*Step 2:* Write all the known substitution values for the first input cell in one row leaving the first cell of the row blank.

*Step 2:* Under the first cell of the row, write all the known substitution values for the second input cell in one column.

*Step 3:* In the first cell of the row (or the first column), fill it with the formula of the output cell (one can also write the formula which equates this cell to the output cell).

*Step 4:* Select the entire table comprising of all row values and column values and click Data > What-If Analysis > Data Table. This will show the following type of dialogue box.



**Step 5:** In the text box against “Row input cells”, enter the cell address on the input cell whose values are written in the first row of the table.

**Step 6:** In the text box against “Column input cells”, enter the cell address on the input cell whose values are written in the first column of the table.

**Step 7:** Click Ok.

**Example:** Prepare an excel sheet that computes the compound amount on a principal amount of Rs 100000 at 5%, 7%, 10%, and 12% rate of interest per year compounded annually for the durations of 1, 2, 5, 7 and 10 years using a two dimensional data table.

**Solution:** Do the following steps

**Step 1:** Solve the problem for one set of input values.

**Step 2:** Write different input values of for duration in a row in cells B10 to E10

**Step 3:** Write different input values of for duration in a row in cells A11 to A15

**Step 4:** Fill the cell A10 with formula =B5

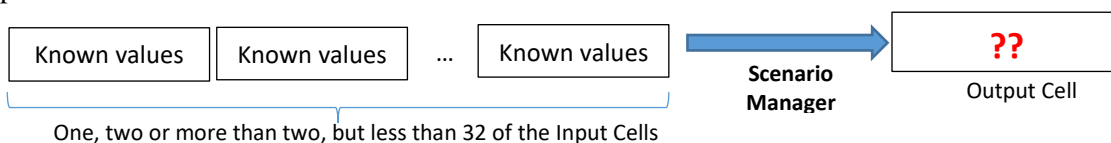
**Step 5:** Select the entire table from A10 to E15. Click on Data Table

**Step 6:** Enter the input cell as B4 in the text box for “Column input cell” and enter the input cell as B3 in the text box for “Row input cell”.

**Step 7:** Click Ok

## Scenario Manager

While Data table is restricted for generating output values by substituting at the most two of the input cells, scenario manager can find the output values against the substitution values for more than 2 of the input cells as well.



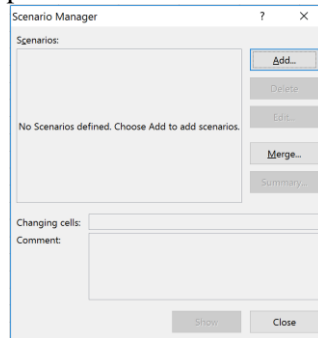
Scenario manager however works only on the given sets of input cell values for which output is to be generated. Each combination of input cells values is called a scenario. The manner scenario manager is used also differs from data table from the perspective that each scenario is to be hand coded in the

scenario manager interface and the output is provided in the form of a separate scenario manger table rather than a table as produced in Data table tool.

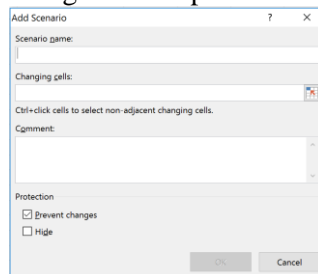
Procedure for creating a two dimensional table is as follow:

*Step 1:* Prepare the solution for any arbitrary values of input cells whose values are to be substituted.

*Step 2:* Invoke Scenario Manager by clicking on Data > What-If Analysis > Scenario Manager. The following dialogue box is provided.

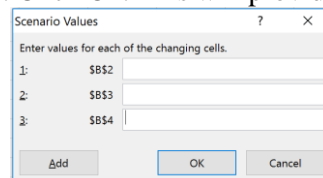


*Step 3:* Click Add. The following dialogue box is provided.



*Step 3:* Enter the scenario name and the cell address of those of input cells whose values are to be substituted.

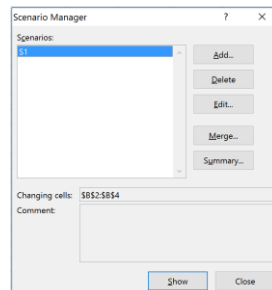
*Step 4:* Give a name to the scenario. Click Ok. This will provide the following type of dialogue box.



The dialogue box will show text boxes for each of the input cell address in which the values of the input cells as per the scenario are to be provided.

*Step 5:* Enter the value corresponding to each input cell address. Click Add.

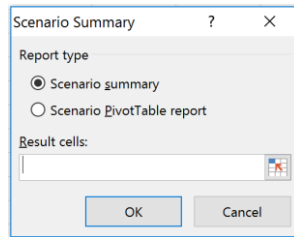
This add one scenario with the Scenario Manager as shown by the updated earlier dialogue box.



*Step 6:* Click on Add button to add more scenarios.

*Step 7:* Select one of the scenario and click on Show to see the input and generated output in corresponding cells.

*Step 8:* Click on Summary. This will provide the following dialogue box.



Step 9: Select Scenario summary radio button and enter the output cell address in the text box for Result Cell. Scenario summary is generated which looks like the following

Scenario Summary			
Current Values:		\$1	2
<b>Changing Cells:</b>			
\$B\$2	250000	100000	250000
\$B\$3	8%	12%	8%
\$B\$4	5	2	5
<b>Result Cells:</b>			
\$B\$5	367332.0192	125440	367332.0192

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.

The scenario summary shows different values of each of the input cells and the generated values of the output cell.

It is important to note that scenario manager does not produce the values of output cell against different scenario in user's table. Instead it generates its own summary table.

**Example:** Compute the compound amounts in the following cases of investment using scenario manager tool of Excel.

1. When principal amount of Rs 100000 is invested at 12% rate of interest for a period of 2 years
2. When principal amount of Rs 250000 is invested at 8% rate of interest for a period of 5 years
3. When principal amount of Rs 300000 is invested at 7% rate of interest for a period of 10 years
4. When principal amount of Rs 200000 is invested at 10% rate of interest for a period of 8 years

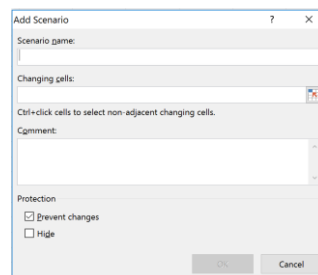
**Solution:** Do the following steps

Step 1: Solve the problem for one set of input values.

	A	B	C	D	E	F
1						
2	Principal Amount	100000				
3	Rate of Interest	12%				
4	Duration	2				
5	Compound Amount	125440				
6						

Input Cells: B2, B3, B4  
Output Cell: B5  
Formula: =B2\*(1+B3)^B4

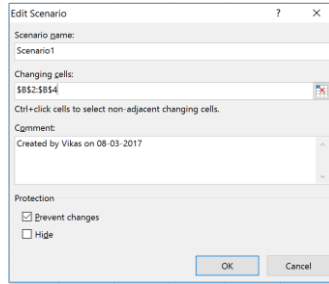
Step 2: Invoke Scenario Manager by clicking Data > What-If Analysis > Scenario Manager



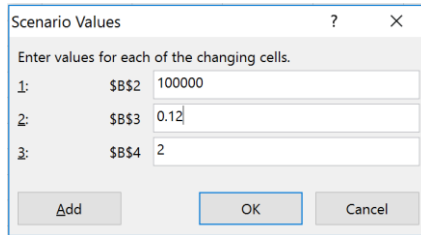
Step 3: Click Add and get edit scenario dialogue box

Step 4: Enter the scenario name e.g. as scenario1 and Enter the addresses of input cells whose values are to be substituted.

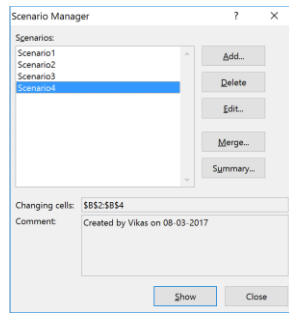




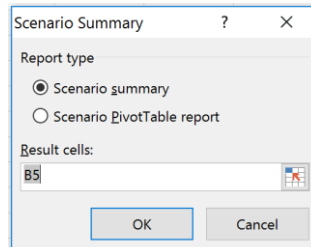
Step 5: Enter the values of first case (scenario) in the Scenario Values dialogue box. Click Ok



Step 6: Repeat the process of remaining cases (scenarios ) as well.



Step 7: Click on Summary and get the following dialogue box.



Step 8: Provide the Result cell as the address of the output cell, i.e., B5 and click Ok. Get the following summary table.

Scenario Summary					
	Current Values:	Scenario1	Scenario2	Scenario3	Scenario4
<b>Changing Cells:</b>					
\$B\$2	100000	100000	250000	300000	200000
\$B\$3	12%	12%	8%	7%	10%
\$B\$4	2	2	5	10	8
<b>Result Cells:</b>					
\$B\$5	125440	125440	367332.0192	590145.4072	428717.762

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.