Analyzing Data and What-if Analysis

By using what-if analysis tools in Microsoft Excel, you can experiment with several different sets of values in one or more formulas to explore all the various results.

For example, you can perform what-if analysis to build two budgets that each assumes a certain level of revenue. Or, you can specify a result that you want a formula to produce, and then determine what sets of values will produce that result. Excel provides several different tools to help you perform the type of analysis that fits your needs.

Overview

What-if analysis is the process of changing the values in cells to see how those changes will affect the outcome of formulas on the worksheet.

Three kinds of what-if analysis tools come with Excel: scenarios, data tables, and Goal Seek. Scenarios and data tables take sets of input values and determine possible results. A data table works only with one or two variables, but it can accept many different values for those variables. A scenario can have multiple variables, but it can accommodate only up to 32 values. Goal Seek works differently from scenarios and data tables in that it takes a result and determines possible input values that produce that result.

In addition to these three tools, you can install add-ins that help you perform what-if analysis, such as the Solver add-in. The Solver add-in is similar to Goal Seek, but it can accommodate more variables. You can also create forecasts by using the fill handle and various commands that are built into Excel. For more advanced models, you can use the Analysis ToolPak add-in.

Use scenarios to consider many different variables

A scenario is a set of values that Excel saves and can substitute automatically in cells on a worksheet. You can create and save different groups of values on a worksheet and then switch to any of these new scenarios to view different results.

For example, suppose you have two budget scenarios: a worst case and a best case. You can use the Scenario Manager feature to create both scenarios on the same worksheet, and then switch between them. For each scenario, you specify the cells that change and the values to use for that scenario. When you switch between scenarios, the result cell changes to reflect the different changing cell values.

Worst case scenario

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>1</td>
<td>Gross Revenue</td>
</tr>
<tr>
<td>2</td>
<td>Cost of Goods Sold</td>
</tr>
<tr>
<td>3</td>
<td>Gross Profit</td>
</tr>
</tbody>
</table>
Changing cells
Result cell

Best case scenario

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gross Revenue</td>
<td>150,000</td>
</tr>
<tr>
<td>2</td>
<td>Cost of Goods Sold</td>
<td>26,000</td>
</tr>
<tr>
<td>3</td>
<td>Gross Profit</td>
<td>124,000</td>
</tr>
</tbody>
</table>

1 Changing cells
2 Result cell

If several people have specific information in separate workbooks that you want to use in scenarios, you can collect those workbooks and merge their scenarios.

After you have created or gathered all the scenarios that you need, you can create a scenario summary report that incorporates information from those scenarios. A scenario report displays all the scenario information in one table on a new worksheet.

Scenario summary report

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Changing Cells:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Gross Revenue</td>
<td>50,000</td>
<td>50,000</td>
<td>150,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Cost of Goods Sold</td>
<td>13,200</td>
<td>13,200</td>
<td>26,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Result Cells:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Gross Profit</td>
<td>36,800</td>
<td>36,800</td>
<td>124,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note  Scenario reports are not automatically recalculated. If you change the values of a scenario, those changes will not show up in an existing summary report. Instead, you must create a new summary report.

Use Goal Seek to find out how to get a desired result

If you know the result that you want from a formula, but you are not sure what input value the formula requires to get that result, you can use the Goal Seek feature. For example, suppose that you need to borrow some money. You know how much money you want, how long a period you want in which to pay off the loan, and how much you can afford to pay each month. You can use Goal Seek to determine what interest rate you must secure in order to meet your loan goal.
Goal Seek works with only one variable input value. If you want to determine more than one input value, for example, the loan amount and the monthly payment amount for a loan, you should instead use the Solver add-in. For more information about the Solver add-in, see the section [Prepare forecasts and advanced business models](#), and follow the links in the See Also section.

### Use data tables to see the effects of one or two variables on a formula

If you have a formula that uses one or two variables, or multiple formulas that all use one common variable, you can use a data table to see all the outcomes in one place. Using data tables makes it easy to examine a range of possibilities at a glance. Because you focus on only one or two variables, results are easy to read and share in tabular form. If automatic recalculation is enabled for the workbook, the data in data tables immediately recalculates; as a result, you always have fresh data.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan Amount</td>
<td>$100,000</td>
</tr>
<tr>
<td>Term in Months</td>
<td>180</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>7.02%</td>
</tr>
<tr>
<td>Payment</td>
<td>($900.00)</td>
</tr>
</tbody>
</table>

Goal seek to determine the interest rate in cell B3 based on the payment in cell B4.

**Note**  Goal Seek works with only one variable input value. If you want to determine more than one input value, for example, the loan amount and the monthly payment amount for a loan, you should instead use the Solver add-in. For more information about the Solver add-in, see the section [Prepare forecasts and advanced business models](#), and follow the links in the See Also section.

### Prepare forecasts and advanced business models

If you want to prepare forecasts, you can use Excel to automatically generate future values that are based on existing data, or to automatically generate extrapolated values that are based on linear trend or growth trend calculations.

You can fill in a series of values that fit a simple linear trend or an exponential growth trend by using the fill handle or the Series command. To extend complex and nonlinear data, you can use...
worksheet functions or the regression analysis tool in the Analysis ToolPak add-in. For more information, follow the links in the **See Also** section.

Although Goal Seek can accommodate only one variable, you can project backward for more variables by using the Solver add-in. By using Solver, you can find an optimal value for a formula in one cell — called the objective cell — on a worksheet.

Solver works with a group of cells that are related to the formula in the objective cell. Solver adjusts the values in the changing cells that you specify — called the variable cells — to produce the result that you specify from the target cell formula. You can apply constraints to restrict the values that Solver can use in the model, and the constraints can refer to other cells that affect the objective cell formula.

Solver is part of a suite of commands sometimes called what-if-analysis tools. With Solver, you can find an optimal (maximum or minimum) value for a formula in one cell — called the objective cell — subject to constraints, or limits, on the values of other formula cells on a worksheet. Solver works with a group of cells, called decision variables or simply variable cells, that participate in computing the formulas in the objective and constraint cells. Solver adjusts the values in the decision variable cells to satisfy the limits on constraint cells and produce the result you want for the objective cell.

**Note** Earlier versions of Solver referred to the objective cell as the "target cell," and the decision variable cells as "changing cells" or "adjustable cells."

**Overview**

Use Solver to determine the maximum or minimum value of one cell by changing other cells. For example, you can change the amount of your projected advertising budget and see the effect on your projected profit amount.

**Example of a Solver evaluation**

In the following example, the level of advertising in each quarter affects the number of units sold, indirectly determining the amount of sales revenue, the associated expenses, and the profit. Solver can change the quarterly budgets for advertising (decision variable cells B5:C5), up to a total budget constraint of $20,000 (cell F5), until the total profit (objective cell F7) reaches the maximum possible amount. The values in the variable cells are used to calculate the profit for each quarter, so they are related to the formula objective cell F7, =SUM(Q1 Profit:Q2 Profit).
Define and solve a problem

1. On the Data tab, in the Analysis group, click Solver.

If the Solver command or the Analysis group is not available, you need to load the Solver Add-in program.

How to load the Solver Add-in program

1. Click the File tab, click Options, and then click the Add-Ins category.
2. In the Manage box, click Excel Add-ins, and then click Go.
3. In the Add-ins available box, select the Solver Add-in check box, and then click OK.

2. In the Set Objective box, enter a cell reference or name for the objective cell. The objective cell must contain a formula.
3. Do one of the following:

   - If you want the value of the objective cell to be as large as possible, click Max.
• If you want the value of the objective cell to be as small as possible, click Min.
• If you want the objective cell to be a certain value, click Value of, and then type the value in the box.

1. In the By Changing Variable Cells box, enter a name or reference for each decision variable cell range. Separate the nonadjacent references with commas. The variable cells must be related directly or indirectly to the objective cell. You can specify up to 200 variable cells.
2. In the Subject to the Constraints box, enter any constraints that you want to apply by doing the following:

   1. In the Solver Parameters dialog box, click Add.
   2. In the Cell Reference box, enter the cell reference or name of the cell range for which you want to constrain the value.
   3. Click the relationship ( <=, =, >=, int, bin, or dif ) that you want between the referenced cell and the constraint.

If you click int, integer appears in the Constraint box. If you click bin, binary appears in the Constraint box. If you click dif, alldifferent appears in the Constraint box.

4. If you choose <=, =, or >= for the relationship in the Constraint box, type a number, a cell reference or name, or a formula.
5. Do one of the following:
   • To accept the constraint and add another, click Add.
   • To accept the constraint and return to the Solver Parameters dialog box, click OK.

Note  You can apply the int, bin, and dif relationships only in constraints on decision variable cells.

You can change or delete an existing constraint by doing the following:

1. In the Solver Parameters dialog box, click the constraint that you want to change or delete.
2. Click Change and then make your changes, or click Delete.

1. Click Solve and do one of the following:

   • To keep the solution values on the worksheet, in the Solver Results dialog box, click Keep Solver Solution.
   • To restore the original values before you clicked Solve, click Restore Original Values.

Notes

• You can interrupt the solution process by pressing ESC. Microsoft Excel recalculates the worksheet with the last values that are found for the decision variable cells.
• To create a report that is based on your solution after Solver finds a solution, you can click a report type in the Reports box and then click OK. The report is created on a new worksheet in your workbook. If Solver doesn't find a solution, only certain reports or no reports are available.
To save your decision variable cell values as a scenario that you can display later, click **Save Scenario** in the **Solver Results** dialog box, and then type a name for the scenario in the **Scenario Name** box.

**Step through Solver trial solutions**

1. After you define a problem, click **Options** in the **Solver Parameters** dialog box.
2. In the **Options** dialog box, select the **Show Iteration Results** check box to see the values of each trial solution, and then click **OK**.
3. In the **Solver Parameters** dialog box, click **Solve**.
4. In the **Show Trial Solution** dialog box, do one of the following:
   - To stop the solution process and display the **Solver Results** dialog box, click **Stop**.
   - To continue the solution process and display the next trial solution, click **Continue**.

**Change how Solver finds solutions**

1. In the **Solver Parameters** dialog box, click **Options**.
2. Choose or enter values for any of the options on the **All Methods**, **GRG Nonlinear**, and **Evolutionary** tabs in the dialog box.

**Save or load a problem model**

1. In the **Solver Parameters** dialog box, click **Load/Save**.
2. Enter a cell range for the model area, and click either **Save** or **Load**.

When you save a model, enter the reference for the first cell of a vertical range of empty cells in which you want to place the problem model. When you load a model, enter the reference for the entire range of cells that contains the problem model.

**Tip** You can save the last selections in the **Solver Parameters** dialog box with a worksheet by saving the workbook. Each worksheet in a workbook may have its own Solver selections, and all of them are saved. You can also define more than one problem for a worksheet by clicking **Load/Save** to save problems individually.

**Solving methods used by Solver**

You can choose any of the following three algorithms or solving methods in the **Solver Parameters** dialog box:

- **Generalized Reduced Gradient (GRG) Nonlinear** Use for problems that are smooth nonlinear.
- **LP Simplex** Use for problems that are linear.
- **Evolutionary** Use for problems that are non-smooth.