

Quick Tutorial for Spreadsheet Solver

The Solver Tool has the capability to solve linear (and often nonlinear) programming problems. Linear and non-linear solvers are available in most commercially available spreadsheets to include Excel, LibreOffice, GoogleSheets, etc. Our Solver Tutorial takes you **step by step** through the process of creating a Solver model, using a Product Mix example. We'll first show you how to (1) load the solver into your spreadsheet, (2) define the problem and write out formulas for the objective and constraints, and (3) solve the problem. We will focus on Microsoft Excel (Mac and PC) and LibreOffice.

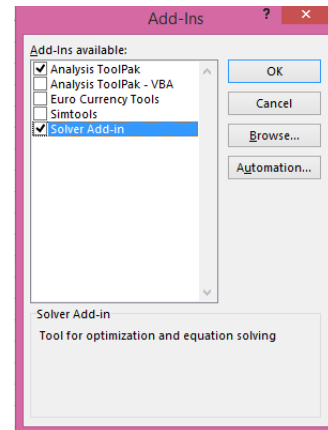
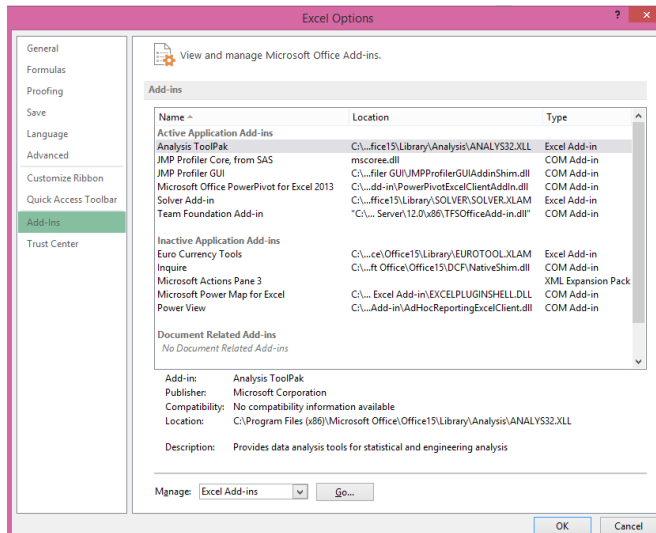
Step 1. Loading the Solver Into Your Spreadsheet

The first step is to make sure you have the correct add-in or solver loaded into your spreadsheet. This process differs by Spreadsheet, operating system, and sometimes version!

Microsoft Excel for PC

Excel does not usually come with the solver loaded. It is considered an Add-In – it is available, you just need to download it. As with most Microsoft tools, it differs whether you are on a Mac or using a PC.

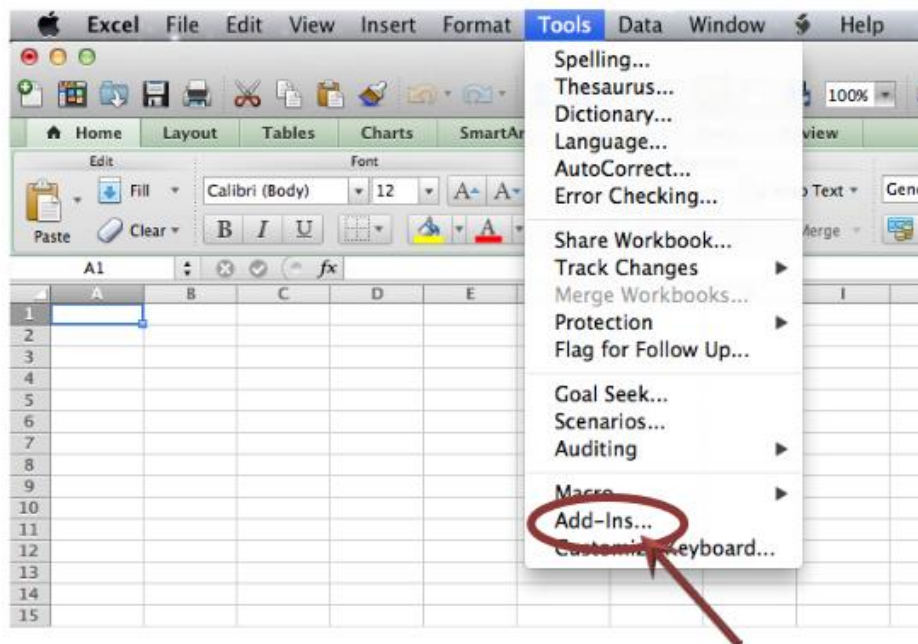
1. Click the Microsoft Office Button, and then click Excel Options.
2. Click Add-Ins, and then in the Manage box, select Excel Add-ins and click Go.
3. In the Add-Ins available box, select the Solver Add-in check box, and then click OK.
4. If Solver Add-in is not listed in the Add-Ins available box, click Browse to locate the add-in.
5. If you get prompted that Solver is not currently installed, click Yes to install it.
6. After you load Solver, the Solver command is available in the Analysis group on the Data tab.

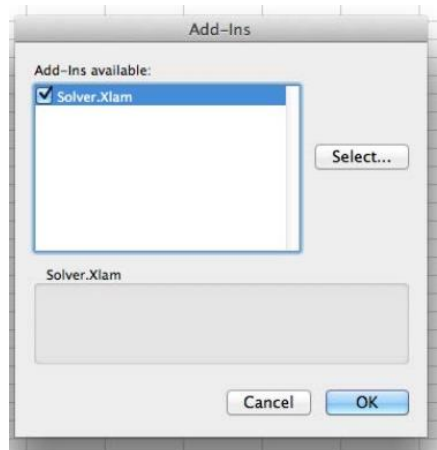


Microsoft Excel for Mac

Loading solver for the Mac differs a little depending on the version of Excel being used. For Excel for Mac 2011 and later, this process works:

1. Open Excel for Mac and begin by clicking on the Tools menu.
2. Click Add-Ins, and then in the Add-Ins box, check Solver.xlam and then click OK.



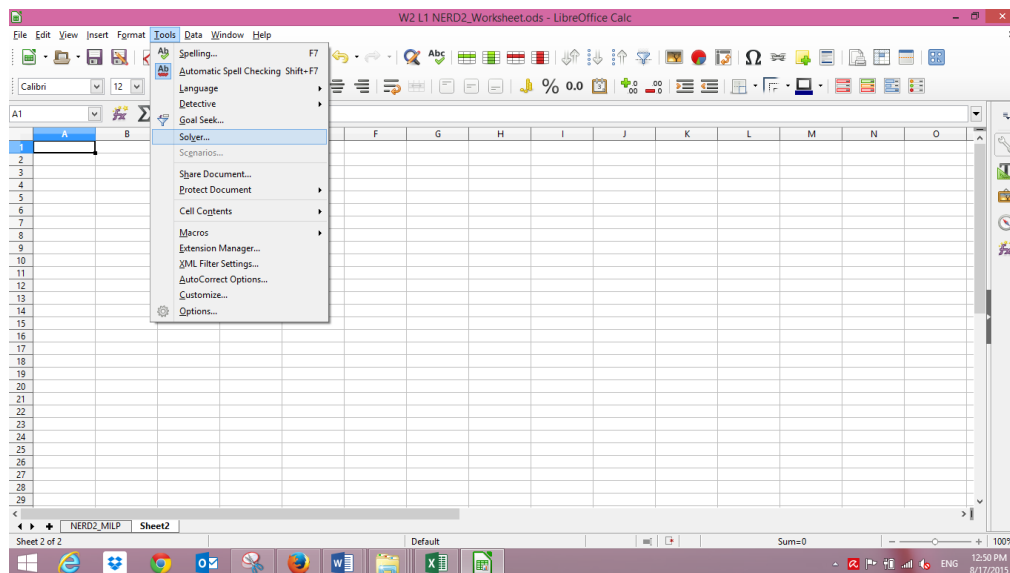


3. After restarting Excel for Mac (fully Quit Excel), select the Data tab, then select Solver to launch. Now on the Tools menu, you should see the Solver command.

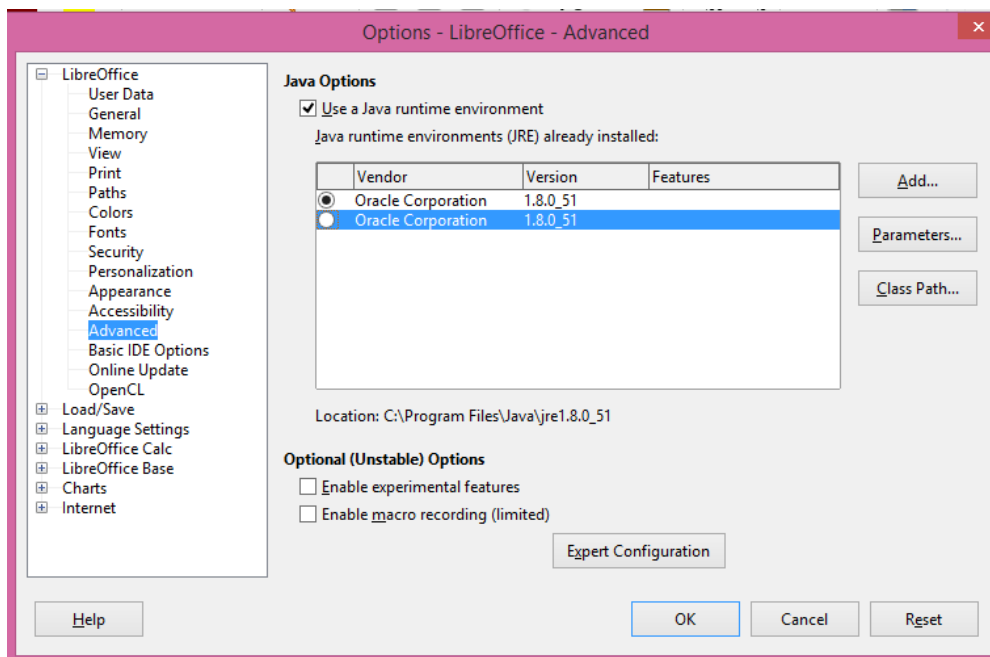
If you have an earlier version of Excel - then see <https://support.microsoft.com/en-us/kb/2431349> for details on where you can locate them.

LibreOffice

The Solver is found at **Tools -> Solver** from the main menu. The solver will then show up as a separate window. At the bottom left of this window you'll find an **Options...** -button. Click this button and make sure **LibreOffice Linear Solver** is selected as the solver engine.



You might also need to define your JAVA JRE client (sometimes an error occurs when launching the solver). In the same **options** tab, go to **Advanced** and select one of the Java Run time Environment installed on your computer and **click OK**



Step 2. Setting up the Problem

The Example Problem

Imagine that you manage a factory that produces **four different types** of wood paneling. Each type of paneling is made by gluing and pressing together a different mixture of pine and oak chips. The following table summarizes the required amount of gluing, pressing, and mixture of wood chips required to produce a pallet of 50 units of each type of paneling:

	Resources Required per Pallet of Paneling Type			
	Tahoe	Pacific	Savannah	Aspen
Glue (quarts)	50	50	100	50
Pressing (hours)	5	15	10	5
Pine chips (pounds)	500	400	300	200
Oak chips (pounds)	500	750	250	500

In the next production cycle, you have 5,800 quarts of glue; 730 hours of pressing capacity; 29,200 pounds of pine chips; and 60,500 pounds of oak chips available. Further assume that each pallet of Tahoe, Pacific, Savannah, and Aspen panels can be sold for profits of \$450, \$1,150, \$800, and \$400, respectively.

Writing the Formulas on the spreadsheet

Before we implement this problem statement in either Excel, let's **write out formulas** corresponding to the verbal description above. If we use the symbol X_1 for the number of Tahoe pallets produced, X_2 for the number of Pacific pallets produced, and X_3 for the number of Savannah pallets produced, and X_4 for the number of Aspen pallets produced, the objective (calculating total profit) is:

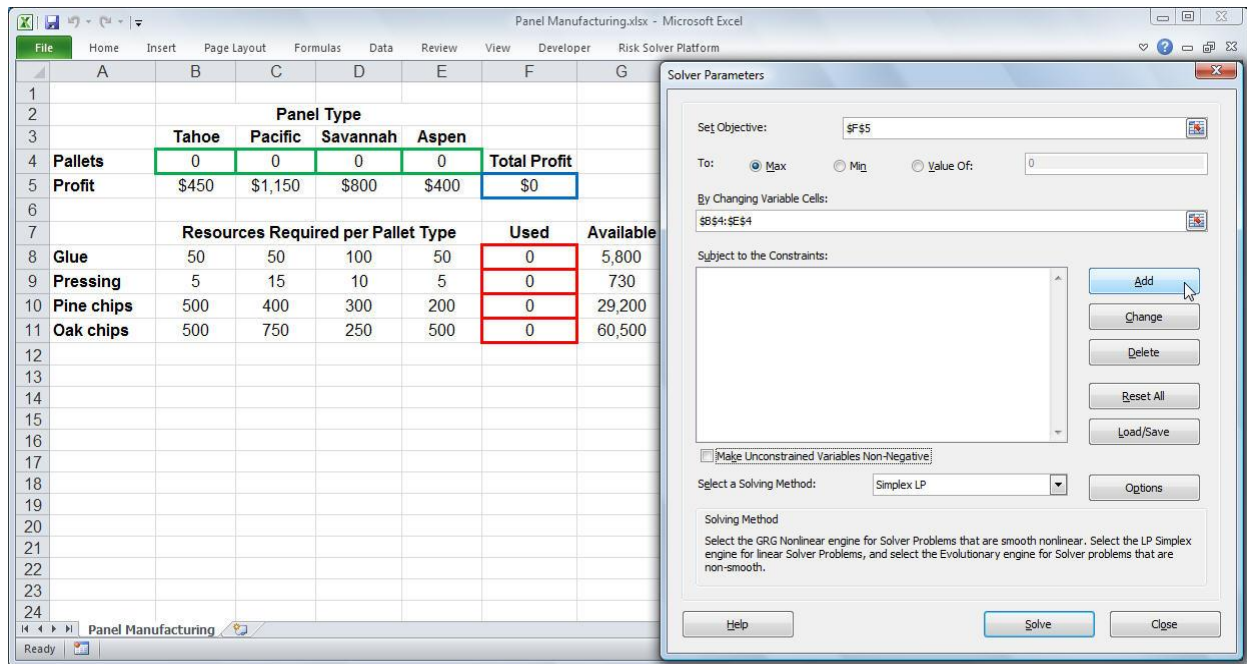
$$\text{Maximize: } 450 X_1 + 1150 X_2 + 800 X_3 + 400 X_4$$

In the worksheet below, we have reserved cells B4, C4, D4 and E4 to represent our **decision variables** X_1 , X_2 , X_3 , and X_4 representing the number of pallets of each type of panel to produce. The Solver will determine the optimal values for these cells.

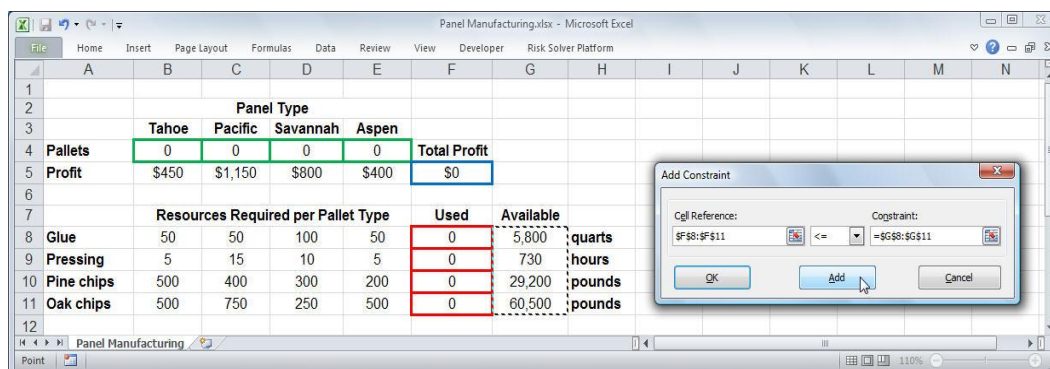
Step 3. Solving the Problem

Microsoft Excel (both Mac & PC)

To let the Excel Solver know which cells on the worksheet represent the decision variables, constraints and objective function, we click Solver button on the Excel Data tab. In the **Set Objective** edit box, we type or click on cell F5, the objective function. In the **By Changing Variable Cells** edit box, we type B4:E4 or select these cells with the mouse.

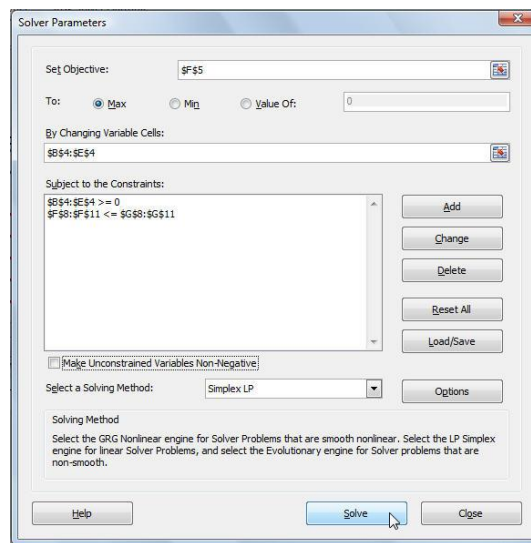


To add the constraints, we click on the **Add** button in the **Solver Parameters** dialog and select cells F8:F11 in the Cell Reference edit box (the *left hand side*), and select cells G8:G11 in the Constraint edit box (the *right hand side*); the default relation \leq is OK. (Click on the image to see it full-size.)



We choose the **Add** button again (either from the Add Constraint dialog above, or from the main Solver Parameters dialog) to define the non-negativity constraint on the decision variables.

When we've completely entered the problem, the Solver Parameters dialog appears as shown below.



Finding and Using the Solution

To find the optimal solution, we simply click on the **Solve button**. After a moment, the Excel Solver returns the optimal solution in cells B4 through E4. This means that we should build 23 pallets of Tahoe panels, 15 pallets of Pacific panels, 39 pallets of Savannah panels, and 0 pallets of Aspen panels. This results in a total profit of \$58,800 (shown in cell F5).

	Panel Type				
	Tahoe	Pacific	Savannah	Aspen	
Pallets	23	15	39	0	Total Profit
Profit	\$450	\$1,150	\$800	\$400	\$58,800

	Resources Required per Pallet Type				Used	Available	
Glue	50	50	100	50	5,800	5,800	quarts
Pressing	5	15	10	5	730	730	hours
Pine chips	500	400	300	200	29,200	29,200	pounds
Oak chips	500	750	250	500	32,500	60,500	pounds

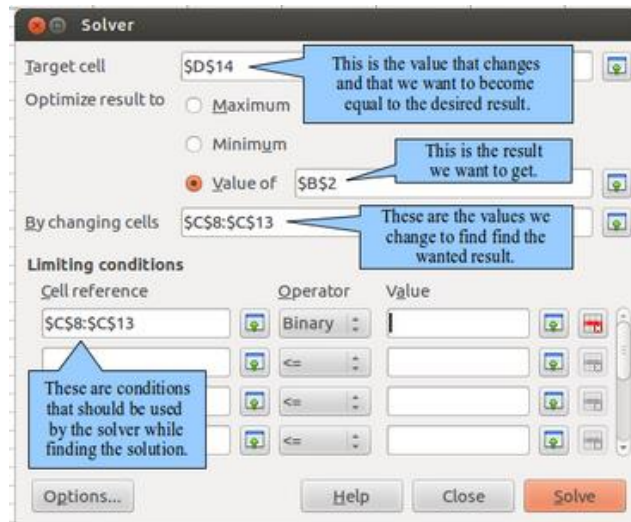
Libre Office

Now we'll start the LibreOffice Solver and insert the **Target Cell**, **Desired result**, the **Cells that needs changing** and the **Limiting Conditions**. Cell locations are given just as an indication on how to use Libre Office. Follow the same procedure as previously to solve the problem.

Cell **D14** is your objective function will change (**Target Cell**) as the solver changes to 0 or 1 in cell range **C8:C13**.

Changes in the cell range **C8:C13** makes Solver check if **D14** has the same value as **B2**. **Limiting conditions** are your **constraints**.

Have a look at the following figure to see the logic of the solver.



Then you just need to follow the same steps as in the Excel tutorial to optimize your solution. The process is described in part 2.

References

There are many references available. We suggest the following as starting places :

- Solver.com : <http://www.solver.com/solver-tutorial-using-solver>
- MIT Open courseware: <http://ocw.mit.edu>