COSC 480/MATH 482
Operations Research
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Excel/Google Spreadsheet Solver Walkthrough

This document should give you a clear walkthrough of an example problem using Excel's Solver (both Windows and Mac) and Google Spreadsheets Solver. At each step, you'll see steps for Excel highlighted in green, and steps for Google Spreadsheets highlighted in red. Note that if you are using Excel 2010 or Mac Excel 2011, there's a good chance that your windows will look slightly differently than the screen shots I have in this document, but this should be good enough for you to figure things out.

Problem Statement

The WYNDOR GLASS CO. produces high-quality glass products, including windows and glass doors. It has three plants. Aluminum frames and hardware are made in Plant 1, wood frames are made in Plant 2, and Plant 3 produces the glass and assembles the products. The company is launching two new products having large sales potential:

Product 1: 8' glass door with aluminum framing ($3000 profit/batch)

Product 2: 4' x 6' double-hung wood-framed window ($5000 profit/batch)

Product 1 requires some of the production capacity in Plants 1 (1 hr/batch) and 3 (3 hr/batch). Product 2 requires Plants 2 (2 hr/batch) and 3 (2 hr/batch). Marketing has determined that the company could sell as many of either product as production allows. Determine what mix of products net the largest profit considering that the amount of available time for Plant 1 is 4 hours, Plant 2 is 12 hours, and Plant 3 is 18 hours per week.

Problem Formulation

Since we're going to be maximizing our profit ("Determine what mix of products net the largest profit") "Product 1: 8' glass door with aluminum framing ($3000 profit/batch) Product 2: 4' x 6' double-hung wood-framed window ($5000 profit/batch)" is our target function statement, since these are the statements that deal directly with profit. Our target function: $Z = 3000a + 5000b$

"Product 1 requires some of the production capacity in Plants 1 (1 hr/batch) and 3 (3 hr/batch). Product 2 requires Plants 2 (2 hr/batch) and 3 (2 hr/batch). Marketing has determined that the company could sell as many of either product as production allows. Determine what mix of products net the largest profit considering that the amount of available time for Plant 1 is 4 hours, Plant 2 is 12 hours, and Plant 3 is 18 hours per week." is where we see our constraints. The constraints are matched by color and form our full set of constraints:

a <= 4

2b <= 12 or b <= 6

3a + 2b <= 18

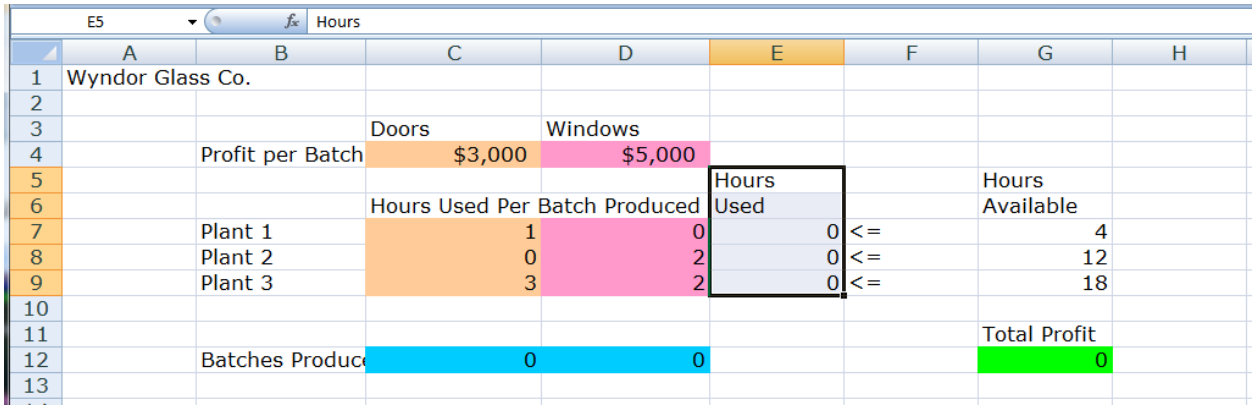
In addition, we can't allow negative production, so *a* and *b* will be non-negative.

In summary:

Maximize:	Z = 3000a + 5000b
Subject To:	a <= 4
	2b <= 12
	3a + 2b <= 18
With:	a, b >= 0

Using a Spreadsheet Solver - Setup

Now that we have our problem formulation, we need to put all of our relevant information into a spreadsheet. This is equivalent across all three potential solvers, so we only put one spreadsheet for now:



E5 | Hours

	A	B	C	D	E	F	G	H
1	Wyndor Glass Co.							
2								
3			Doors	Windows				
4		Profit per Batch	$3,000	$5,000				
5					Hours		Hours	
6			Hours Used Per Batch Produced		Used		Available	
7		Plant 1	1	0	0	<=	4	
8		Plant 2	0	2	0	<=	12	
9		Plant 3	3	2	0	<=	18	
10								
11							Total Profit	
12		Batches Produc	0	0			0	
13								

Looking at specific cells (note that the highlights are completely optional):

G7, G8, G9 – these cells are the coefficients of the left hand sides of our three constraints
C7:C9, D7:D9 – these cells are the right hand sides of our three constraints
C4, D4 – these cells are our profit per unit for each of our products
C12, D12 – these cells we start as 0 and will be adjusted by the Solver. They represent the number of units of each product.

In addition, we'll need some cells that will do some calculations for us. Under "Hours Used":

E7 – "= C7*C12"
E8 – "= D8*D12"
E9 – "= C9*C12 + D9*D12"

Each of these equations represent multiplying the hours used per unit for each plant (rows 7-9) by the number of units (row 12).

We'll also need one more calculation, for our total profits (our Z function):

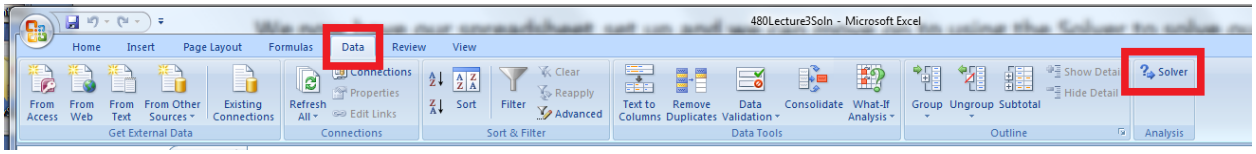
G12 – "= C12*C4 + D12*D4"

Using a Spreadsheet Solver – Solving!

We now have our spreadsheet set up and we can move on to using the Solver to solve our linear programming problem. If you don't already have a variant of Solver installed, see the section on installation (Google's is built-in).

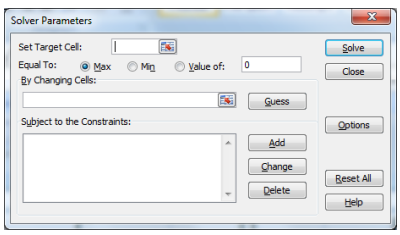
To start, we need to fire up Solver by clicking on Solver in Excel or Tools -> Solver in Google Spreadsheets.

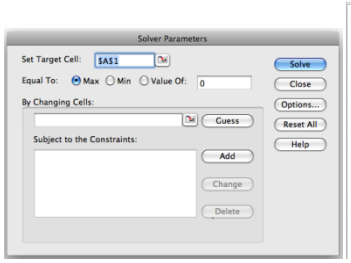
To find Solver in Excel: Click on Data, then Solver.

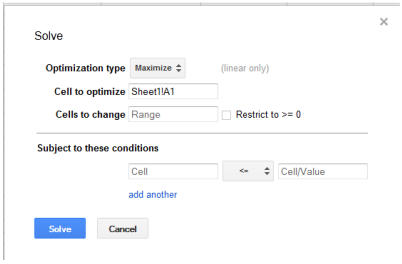


For Mac, start the Solver app.

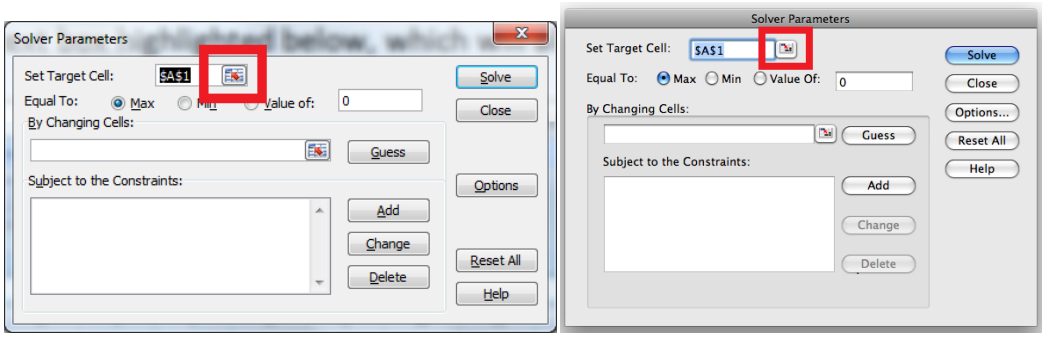
You should see one of the following screens (Windows, Mac, Google):







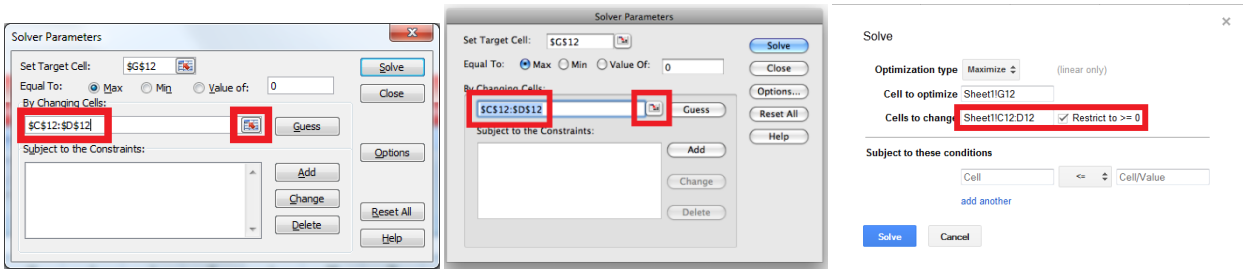
The first thing we'll set is the cell that we want to optimize, or the cell that has our Z function. We'll be setting Set Target Cell/Set Objective, or Cell to Optimize. For Google, you'll need to put the cell in manually by adjusting the "A1" portion of the Cell to Optimize box or by clicking on the textbox then clicking on the desired cell. For Office, you can click on the little button next to the text box highlighted below, which will allow you to click a specific cell.



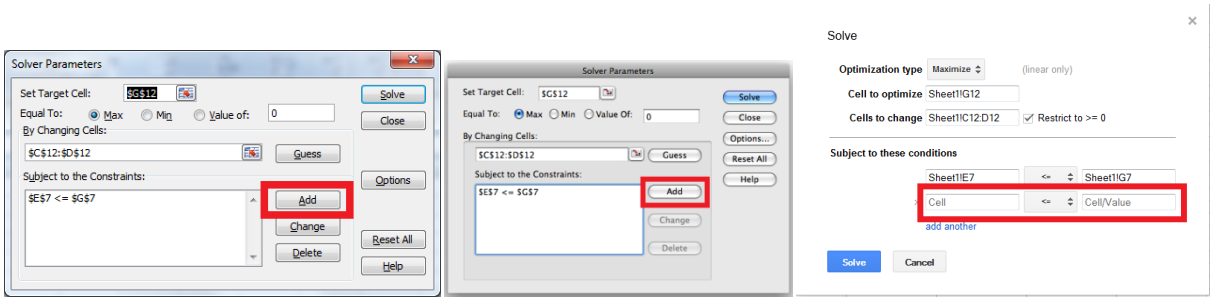
In either case, you want to make sure that the cell is the right one. In our example above, we want this cell to be G12, but it may be different depending on how you have things formatted.

The next item to address is to choose what cells are to be manipulated by the software in order to maximize (or minimize as the case may be) our target cell. In Excel, this is handled by the "By Changing Cells:" textbox, in Google this is taken care of by the "Cells to Change" textbox. One special note – the Google textbox allows you to put your non-negative conditions in at the same time. Just check the box next to the textbox. Again, in the Excel version, we have a button to the right side of the textbox that allows us to choose our cells, and in the Google version, we have to manually enter that information or click on the textbox then click on the appropriate cell. The various pieces are highlighted below:

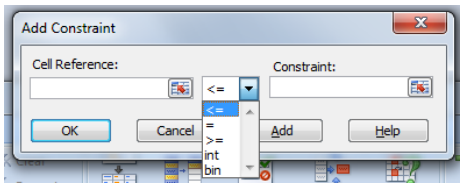
For our example, we want the cells C12 and D12 because the numbers of units that we produce are the parameters we can directly control.



Finally, we add in our constraints. This is done through the "Add" button on Excel variants, and by the appropriate textbox on Google Spreadsheets. The first constraint has already been added in both examples.

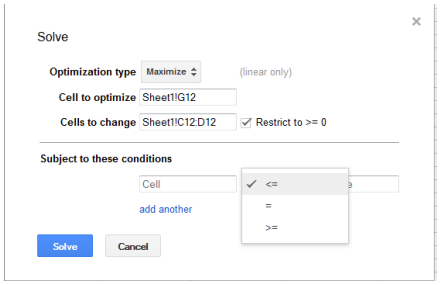


When you click Add in Excel, you'll get some options:



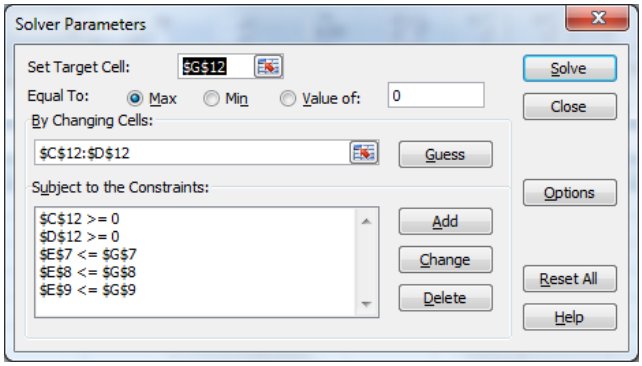
<=, =, and >= are self-explanatory. int and bin are constraints that allow you to ensure that a particular cell remain an integer or a binary (0 or 1) value.

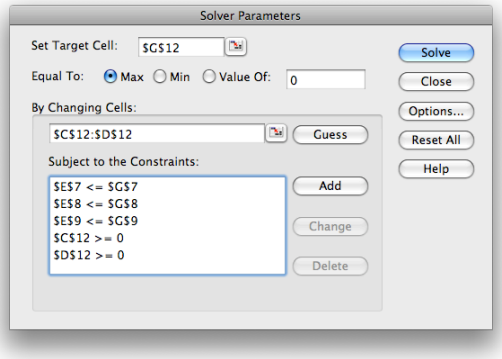
Google's solver only allows you <=, >=, and =:

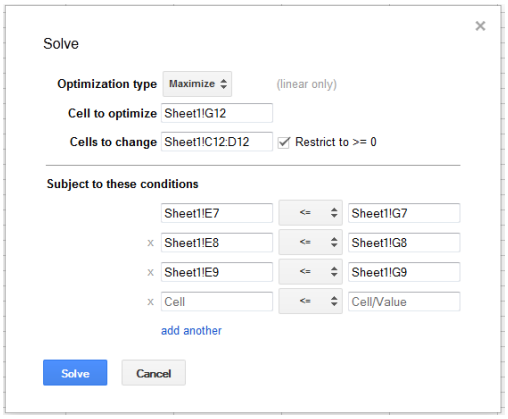


Now, add our constraints: E7 <= G7, E8 <= G8, and E9 <= G9. In Excel, you'll also need to add the nonnegativity constraints: C12 >= 0, D12 >= 0 (though you can do this in the options panel as well).

When finished, your solver should look like one of these three:







Click “Solve” and magic happens! Feel free to mess around with the Options panel (only available in Excel). These options will allow you to further restrict your model and solver parameters.

Using a Spreadsheet Solver – Installation

Mac Office 2008 and 2011 – Go to http://www.solver.com/mac/, download the Solver application and install. You will run this at the same time as Excel.

Office 2007 and 2010 – Click on the Office button (top left), then click on Excel Options. Click on Add-Ins, then in the Manage box (bottom leftish) make sure that Excel Add-ins is selected and then click Go. In the Add-Ins available box, select Solver Add-in then hit ok and follow the prompt.

~ *Fin* ~