Solving Linear Programs in Excel

Notes for AGEC 622

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Solving Linear Programs in Excel

- http://ageco.tamu.edu/faculty/mccarl/622class/LP with excel example.xls
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Before beginning you must have a tableau of the linear programming model you wish to solve.

Here we will solve a the model from overhead set 3 which is as follows

$$
\begin{array}{llllll}
\text{Maximize } Z = & 2000\, X_{fancy} + & 1700\, X_{fine} & +1200\, X_{new} & & \\
\text{s.t.} & X_{fancy} + & X_{fine} + & X_{new} & \leq & 12 \\
 & 25\, X_{fancy} + & 20\, X_{fine} + & 19\, X_{new} & \leq & 280 \\
 & X_{fancy}, & X_{fine}, & X_{new} & \geq & 0
\end{array}
$$

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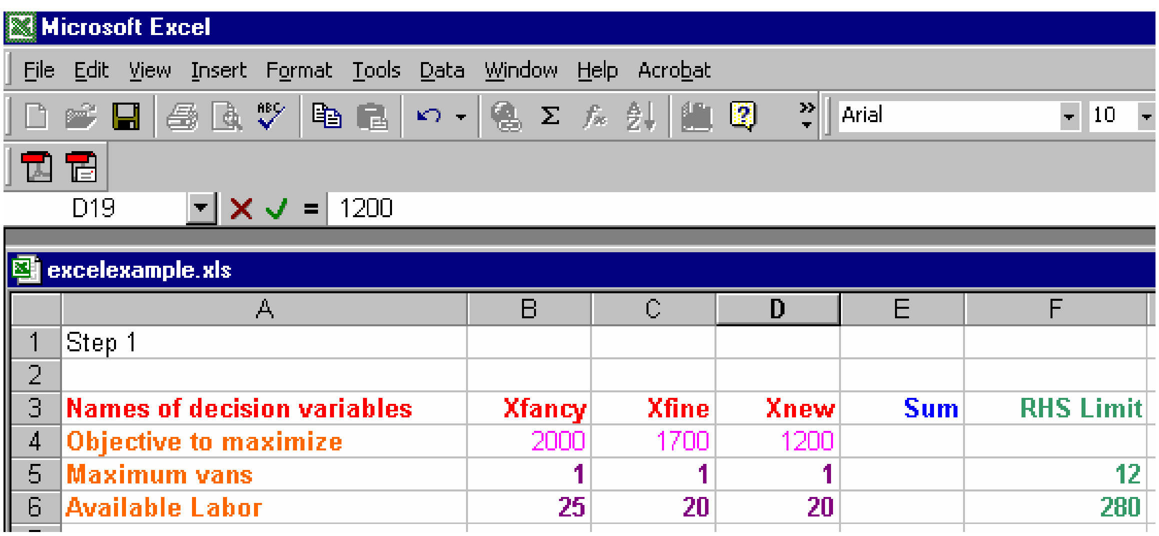
Solving Linear Programs in Excel

Step by step instructions to put LP into Excel

1) Put the problem into Excel. Put the objective function coefficients into a row with **at least 2 blank rows above it** with the constraint coefficients below. Label the rows down the left hand side in column 1. Leave one blank column after the last variable and label it sum. Then put in the RHS. Put names for each variable above the variables in the row just above the objective function coefficients. Label that row Names of decision variables. The resultant spreadsheet is



	A	B	C	D	E	F
1	Step 1					
2						
3	Names of decision variables	Xfancy	Xfine	Xnew	Sum	RHS Limit
4	Objective to maximize	2000	1700	1200		
5	Maximum vans	1	1	1		12
6	Available Labor	25	20	20		280

Solving Linear Programs in Excel

2) Now label the row just above tableau (I am using rows 10 and on since I have the tableau above in the first few lines) **Variable values to manipulate**. **Enter 0 values above the variables**. These are the cells that Excel will "change" to find the optimum solution to the problem.

9						
10	Variable values to manipulate	0	0	0		
11	Names of decision variables	Xfancy	Xfine	Xnew	Sum	RHS Limit
12	Objective to maximize	2000	1700	1200		
13	Maximum vans	1	1	1		12
14	Available Labor	25	20	20		280
15						

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3) Now construct Excel cell entries to add up each LP model equations. Place these in the column named Sum. These will involve adding the numbers in each equation times the numbers from the **Variable values to manipulate row**. Namely with **Variable values** in row **17** and the objective function in row 19 enter the equation +B19***B$17**+C19***C$17** +D19***D$17**. This equation adds each term in equation times each **variable value**. Thus if you have 20 variables you would have 20 terms. Note use of **$** against elements from the **variables to manipulate** row allow this equation to be copied for each constraint. Then copy this formula for each constraint equation.

E19 = =+B19*B$17+C19*C$17+D19*D$17

excelexample.xls

	A	B	C	D	E	F
15						
16						
17	Variable values to manipulate	0	0	0		
18	Names of decision variables	Xfancy	Xfine	Xnew	Sum	RHS Limit
19	Objective to maximize	2000	1700	1200	0	
20	Maximum vans	1	1	1	0	12
21	Available Labor	25	20	20	0	280

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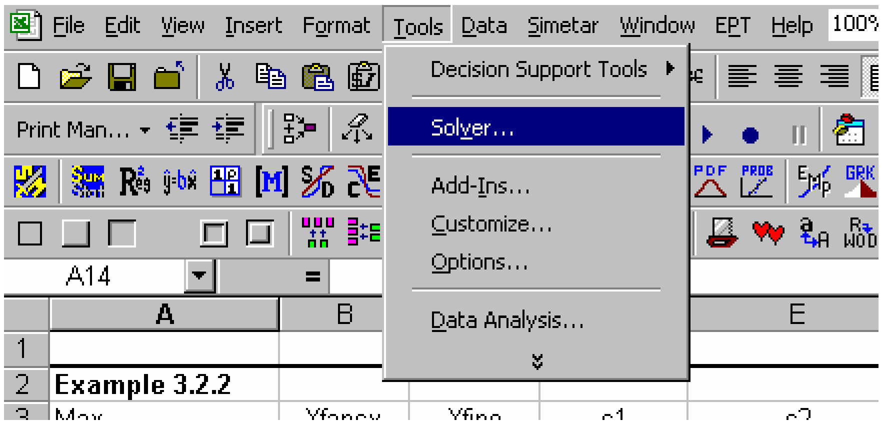
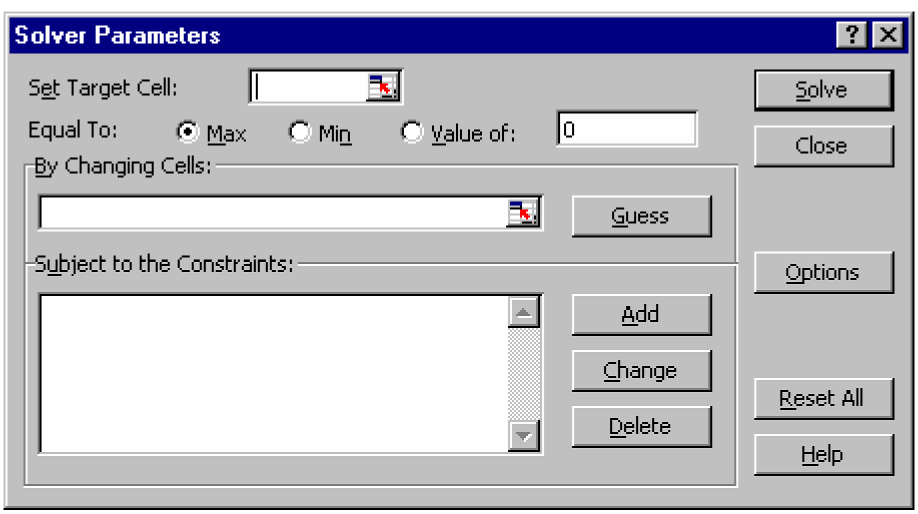
4) Activate the solver. To do this go to Tools in the toolbar and click on Solver.



¨Note If Solver is not there, got to Add-Ins and click on Solver Add-In to install Solver.

The following dialogue then appears:



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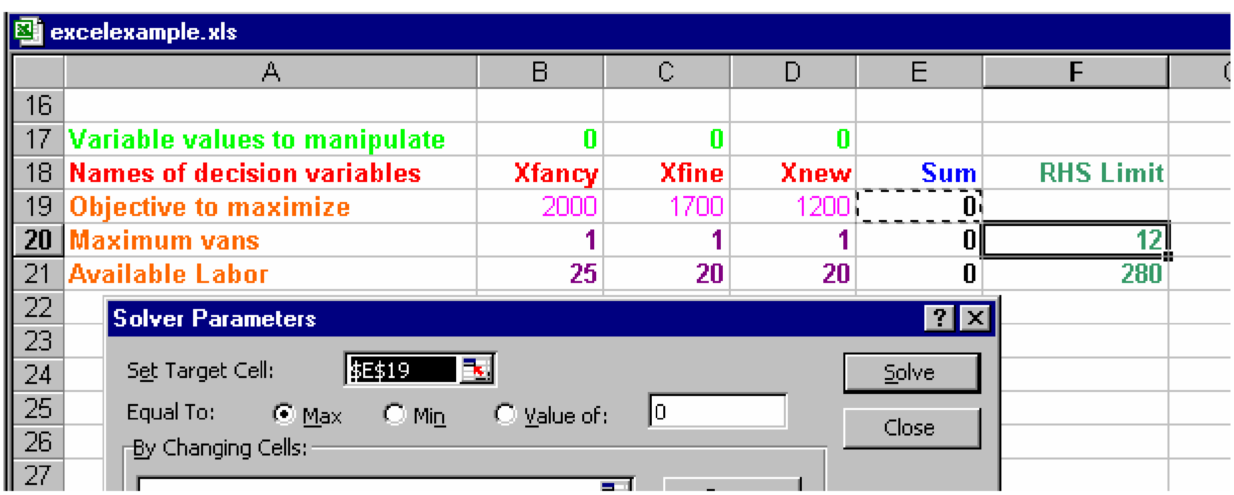
5) Define where the objective function is by defining the variable dialogue box called **Set Target Cell** as the cell number where you added the objective function up. Note in this case I use D$19 which is in the row for the Objective to manipulate and the Sum column . That entry gives the the formula involving the **decision variables values in row 17** times the objective function coefficients in row 19 accumulated across all decision variables.



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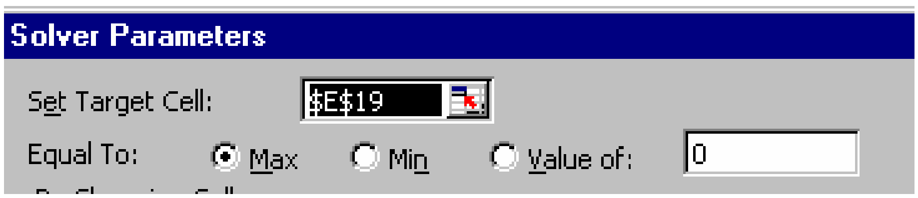
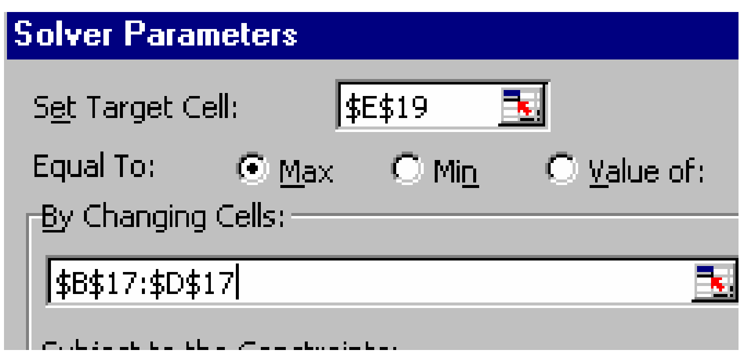
6) Choose whether to maximize or minimize using the **buttons** just below the Set Target Cell box.



7) Identify the **decision variables** by entering the range in which they fall in the **By Changing Cells** box



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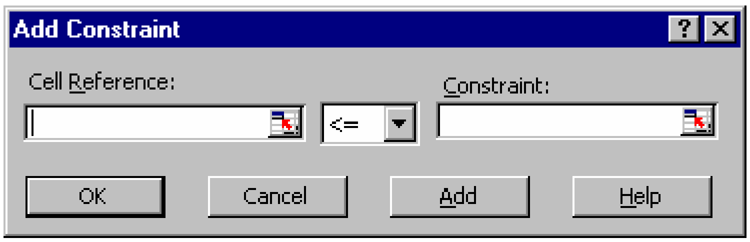
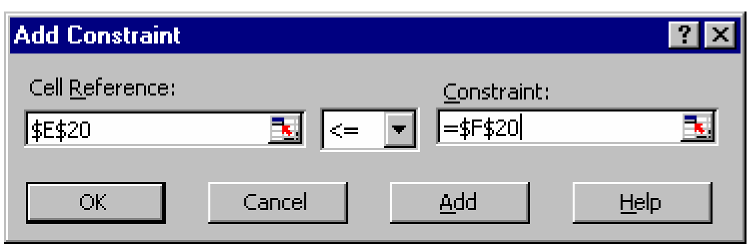
8) Enter consideration of the constraint equations into the model by clicking the **Add button** to the right of the Subject to the Constraints box. You then get the dialogue below



Now recognize our first constraint says the sum in cell E20 is less than or equal to the constant in cell F20. Enter this in the dialogue box as follows and click **OK**



Repeat for the other constraint.

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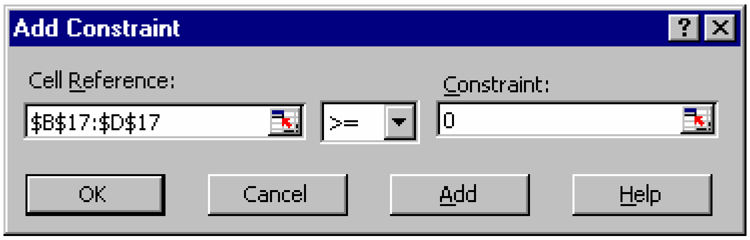
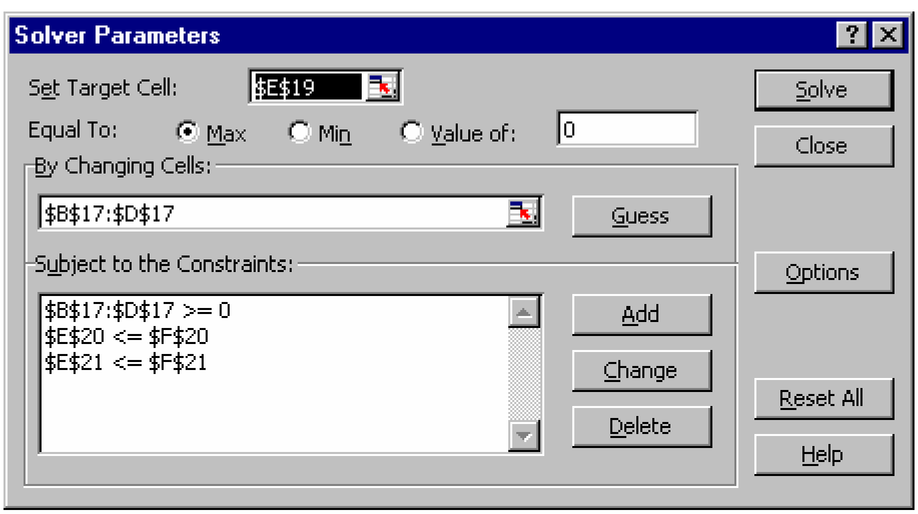
9) Enter the nonnegativity conditions



specifying the range of decision variables are >= 0 as above.

10) Review the problem and when all looks right Solve by clicking the solve button



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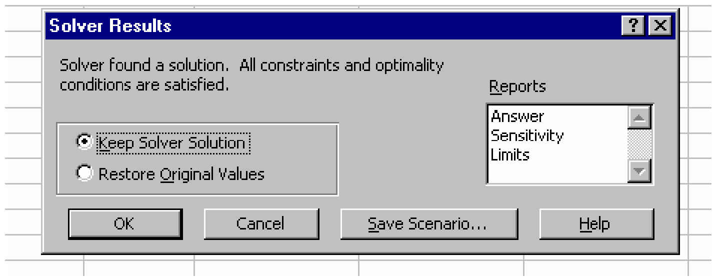
11) Excel will solve LP problem based on the formulas you inputted. When Excel finds an optimal solution, the following appears.



12) Choose desired output reports. Highlight both (hold down the control key) the Answer Report and Sensitivity Report. Click on Keep Solver Solution and OK then the Reports will be generated.

You will see that Excel has entered optimal **Decision Levels** and Total Resource Use in proper cells. And added two new sheets one with the answer and the other for sensitivity.

16						
17	Variable values to manipulate	8	4	0		
18	Names of decision variables	Xfancy	Xfine	Xnew	Sum	RHS Limit
19	Objective to maximize	2000	1700	1200	22800	
20	Maximum vans	1	1	1	12	12
21	Available Labor	25	20	20	280	280

Answer Report 1 / Sensitivity Report 1 / Basic Problem

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13) Look at the Answer sheet. It contains optimal decision variables (in the adjustable cells portion under final value) and the optimal objective function(in the target cells portion under final value)

Target Cell (Max)

Cell	Name	Original Value	Final Value
$E$19	Objective to maximize Sum	0	22800

Adjustable Cells

Cell	Name	Original Value	Final Value
$B$17	Variable values to manipulate Xfancy	0	8
$C$17	Variable values to manipulate Xfine	0	4
$D$17	Variable values to manipulate Xnew	0	0

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$E$20	Maximum vans Sum	12	$E$20<=$F$20	Binding	0
$E$21	Available Labor Sum	280	$E$21<=$F$21	Binding	0
$B$17	Variable values to manipulate Xfancy	8	$B$17>=0	Not Binding	8
$C$17	Variable values to manipulate Xfine	4	$C$17>=0	Not Binding	4
$D$17	Variable values to manipulate Xnew	0	$D$17>=0	Binding	0

Answer Report 1 / Sensitivity Report 1 / Basic Problem

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14) Look at the sensitivity sheet. It has reduced costs and shadow prices.

Adjustable Cells

Cell	Name	Final Value	Reduced Gradient
$B$17	Variable values to manipulate Xfancy	8	0
$C$17	Variable values to manipulate Xfine	4	0
$D$17	Variable values to manipulate Xnew	0	-500

Constraints

Cell	Name	Final Value	Lagrange Multiplier
$E$20	Maximum vans Sum	12	500
$E$21	Available Labor Sum	280	60

Reduced cost called reduced gradient

Shadow price called Lagrange multiplier

Reduced cost is another important LP concept and is an estimate of how much the objective function will change when forcing in one unit of a variable that is non basic (zero) in the optimal solution.