Introduction to LP: Part II Using MS Excel to solve an LP

Firstly, you should know that there are several very good software programs available to solve linear programs. The most popular academic packages include CPLEX, LINDO, and AMPL. These systems can be run as standalone software packages, or be linked as compiled libraries into other programs that need to run an LP internally. If you search the web, you will find several decent java applets that can solve small LP's. We will use the solver function of Microsoft Excel (which has several functions, one of which is solving LP's).

The rest of these notes will be written like a lab handout.

0. Ensure that Excel solver is linked

You should have an option called "***Solver…***" under the "***Tools***" menu. If not, you must first link the solver libraries with Excel. To do so, select the menu item ***Tools → Add-Ins…***, and make sure that the option with a name "***Solver add in***" is checked.

1. Set up the problem data

Here is one possible way to enter your problem data. We will follow the method of our lecture examples, and arrange the data as follows:
(a) The decision variables
(b) The objective function
(c) The constraints

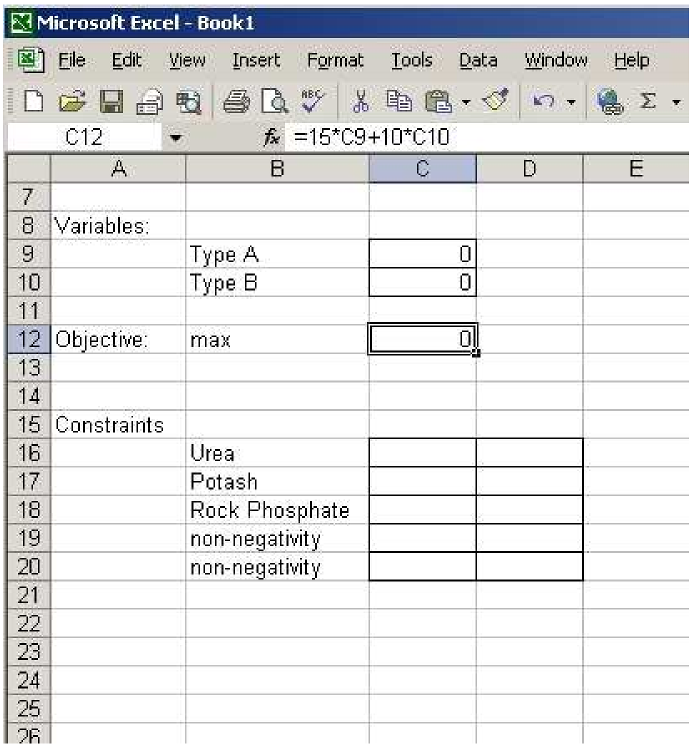
We will enter text to describe each item, since this will make it easier for us to debug any data-entry errors (typed the wrong value or formula), or modeling errors (we either forget to enter some constraint, or typed a wring expression).

Let's see how it can be done for our Product Mix example. Here is the formulation:

maximize	$z(x, y) = 15x + 10y$	[objective]
subject to	$2x + y \leq 1500$	[Urea]
	$x + y \leq 1200$	[Potash]
	$x \leq 500$	[Rock phosphate]
	$x \geq 0$,	[non-negativity]
	$y \geq 0$	[non-negativity]

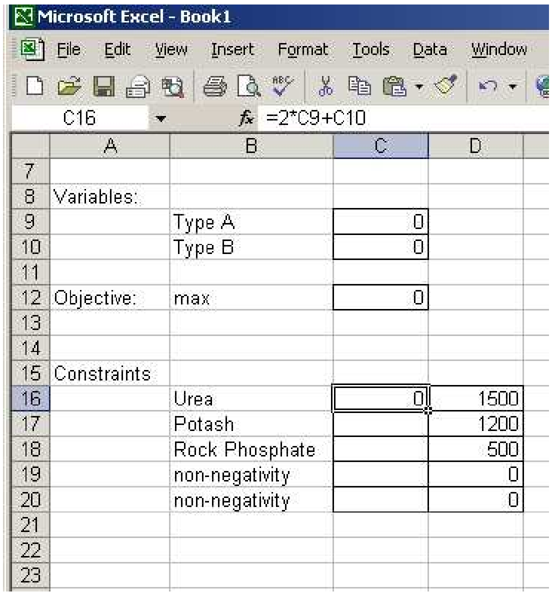
In the following screenshot, we input this model.
The variables: We use one cell for each variable (in the example, I am using cell C9 for x, and C10 for y. Initially, you ay enter some arbitrary value for each variable, e.g. 0.

The objective function: I am using the cell C12 for the objective function. In this cell, we enter the expression for the objective function in terms of the variables. To do so, you enter the "formula" for the cell, as shown in the text-box in the toolbar area after the symbol f_x. Don't forget that formulas are identified by an initial '=' sign in Excel.

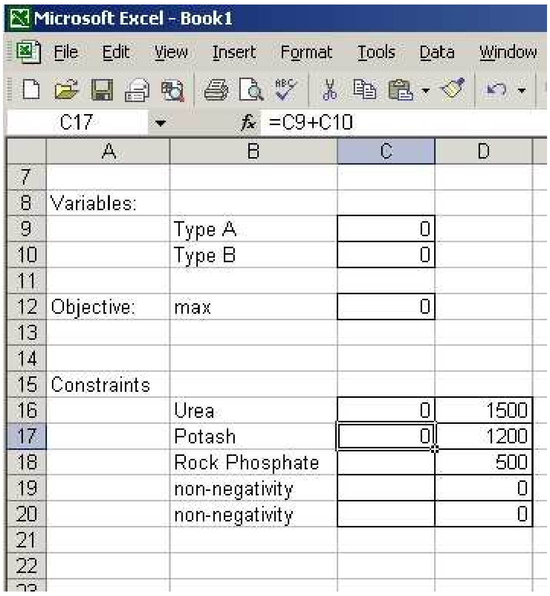


Specification of the objective function

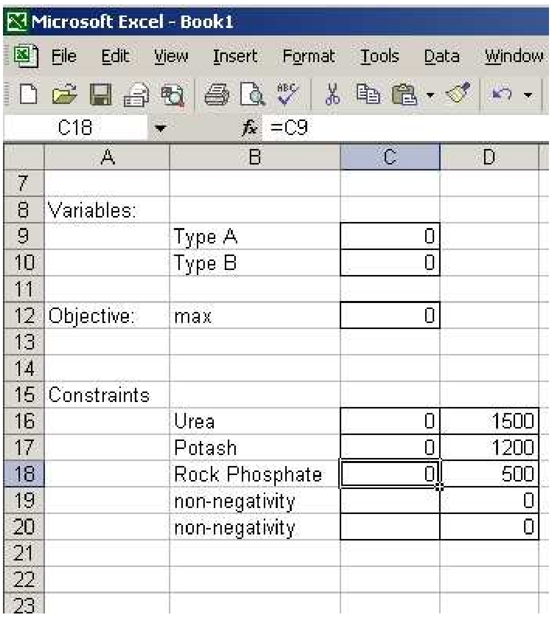
The constraints: For each constraint, we set up two cells. The left cell is used to enter the expression of the constraint, and the right cell for the constant. The following figures show the formula entries for the constraints.



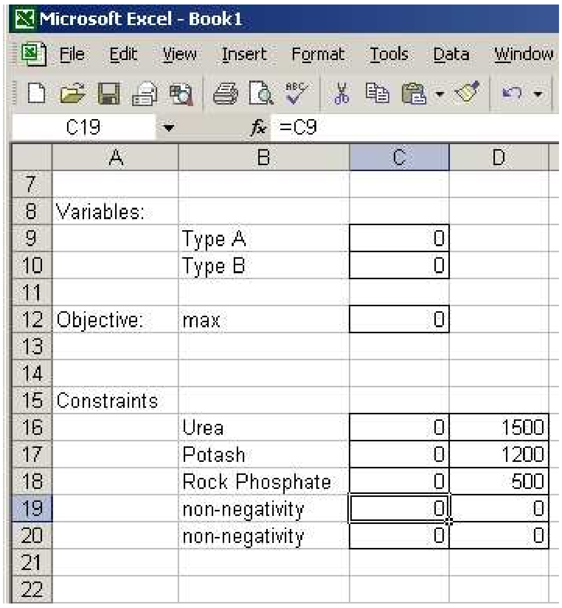
Constraint for Urea



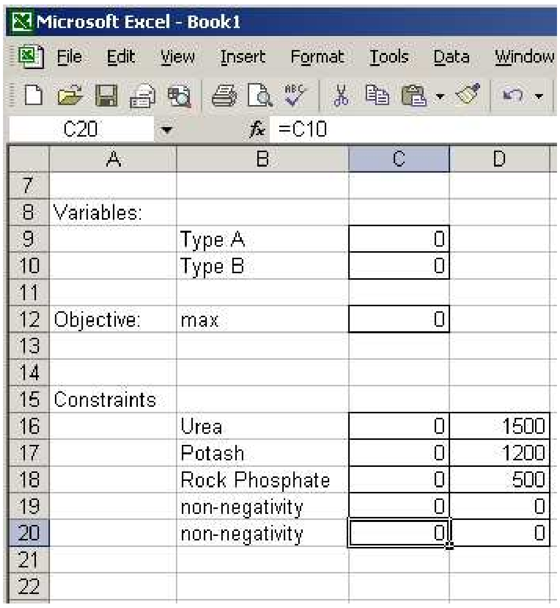
Constraint for Potash



Constraint for Rock Phosphate



Constraint for non-negativity of x

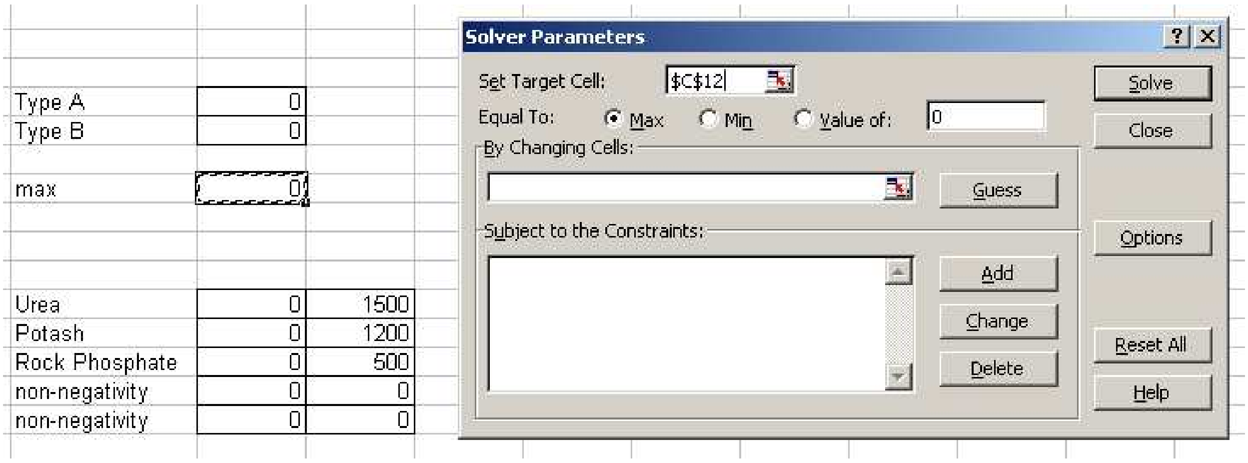


Constraint for non-negativity of y

This completes the data entry for the problem, and we can specify the problem to the solver.

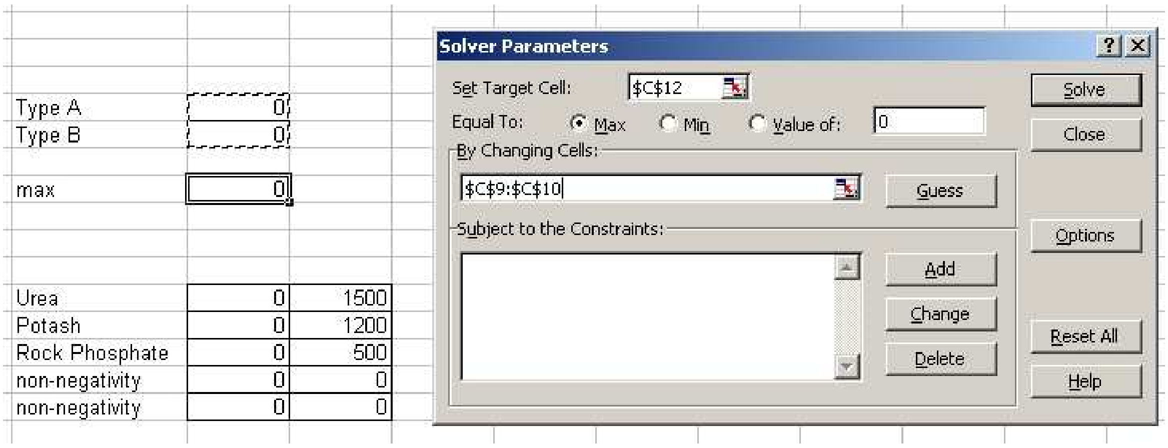
2. Set up the solver

2.1. Select ***Solver…*** from the ***Tools*** menu. You will get a dialog box to specify the problem.
2.2. First click in the "***Set Target Cell:***" box, and specify the cell with the expression for the objective function. This can be done by either typing the cell address (using relative coordinates, C12, or absolute coordinates, $C$12), or by a single mouse-click on the cell (C12).
2.3. Next, specify what you ant to do to the objective (in our case, Maximize its value), by selecting the appropriate radio-button (in our case, ***Max***).



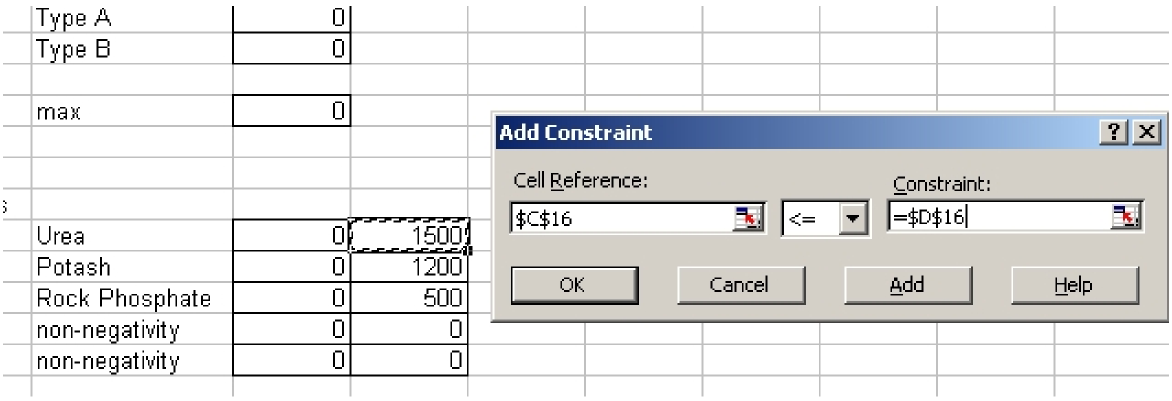
Specification of the objective

2.4. Specify the variables; this is done by first clicking inside the box named "***By Changing Cells:***", and entering into it the *range* of cells that hold the input variables (in our case, cells C9:C10, or using absolute coordinates, $C$9:$C$10).



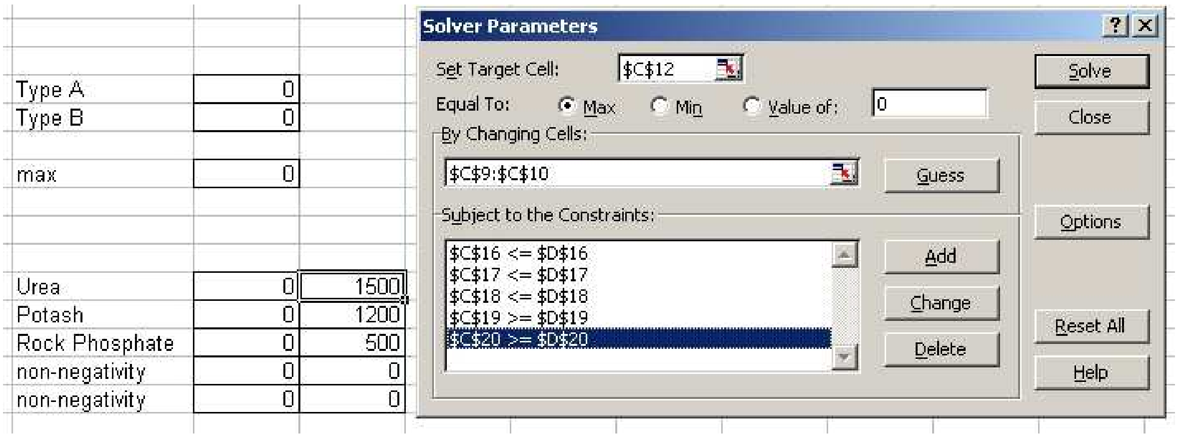
Specification of the variables

2.5. Finally, we need to specify the constraints. Click on the text-box titled "***Subject to the constraints:***", and then click on the "***Add***" button. A new dialog box pops up, that allows you to specify a constraint. The screen-shot below shows the constraint for Urea. Each constraint requires three inputs, the left-hand-side expression, the relation (<, ≤, etc.), and the right-hand-side constant.



Specification of the constraints

You must add each constraint by repeatedly clicking on the "***Add***" button and specifying the constraint until all of them have been specified. At this point, the dialog box shows the entire formulation, as shown in the next screen-shot.



Ready to solve

2.6. Click on the "***Solve***" button, and the solution pops up. The values of the variables and the objective will be automatically be updated. You should see the optimum value of the objective function (in our case, z* = 13500), and the variables (x* = 300, y* = 900).

2.7. Reports and clean-up: Excel gives you the option to generate reports for the LP. Select the three options, ***Answer***, ***Sensitivity***, and ***Limits***. If want to store the problem in the form that you entered it, check the option for "***Restore Original Values***".

The answer page gives you a summary of the results, including the optimum objective value, the optimal solution, the constraints that participate in the optimal solution and the slack related to each non-binding constraint. The sensitivity page provides some more useful information, including how sensitive the optimal solution is relative to the constraints.

A little extra: if you want to see how the problem was getting solved, click on the ***Options*** button in the Solver dialog box, and check the item "***Show Iteration Results***". This will step you through each step of the solution, so you can see how Simplex is cranking through the problem. Unfortunately, the details of the Simplex tableau at each step are not shown.