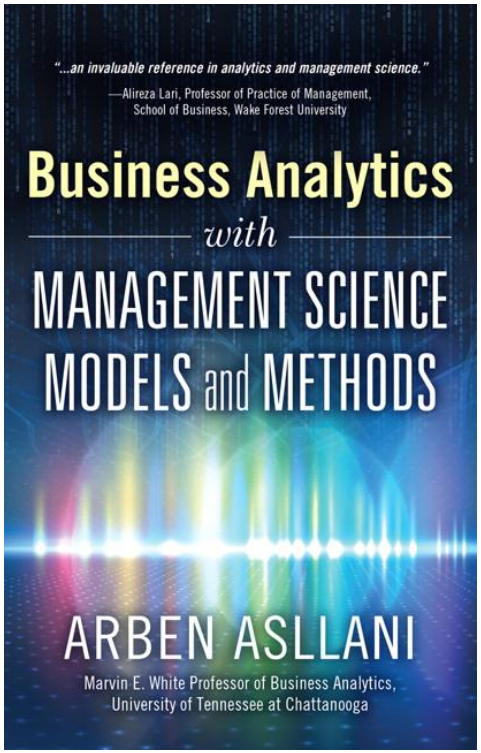
Business Analytics
Prescriptive Models



Based on

Business Analytics With Management Science Models and Methods

by

Arben Asllani

Appendix B

A BRIEF TOUR OF SOLVER

Business Analytics with Management Science Models and Methods

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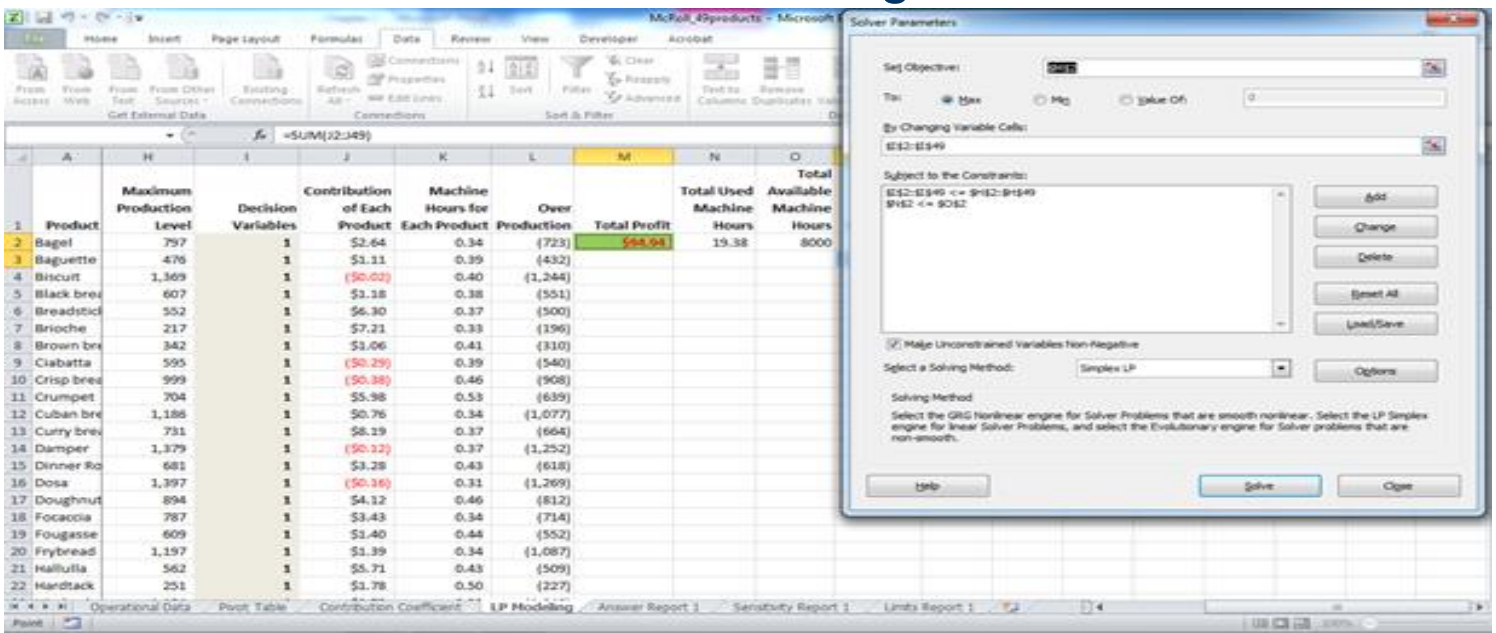
Steps to solve LP Models with Excel Solver

1. Set up Constraints and Objective Function in Solver
2. Select Solver Options
3. Generate the Solution
4. Analyze the Results

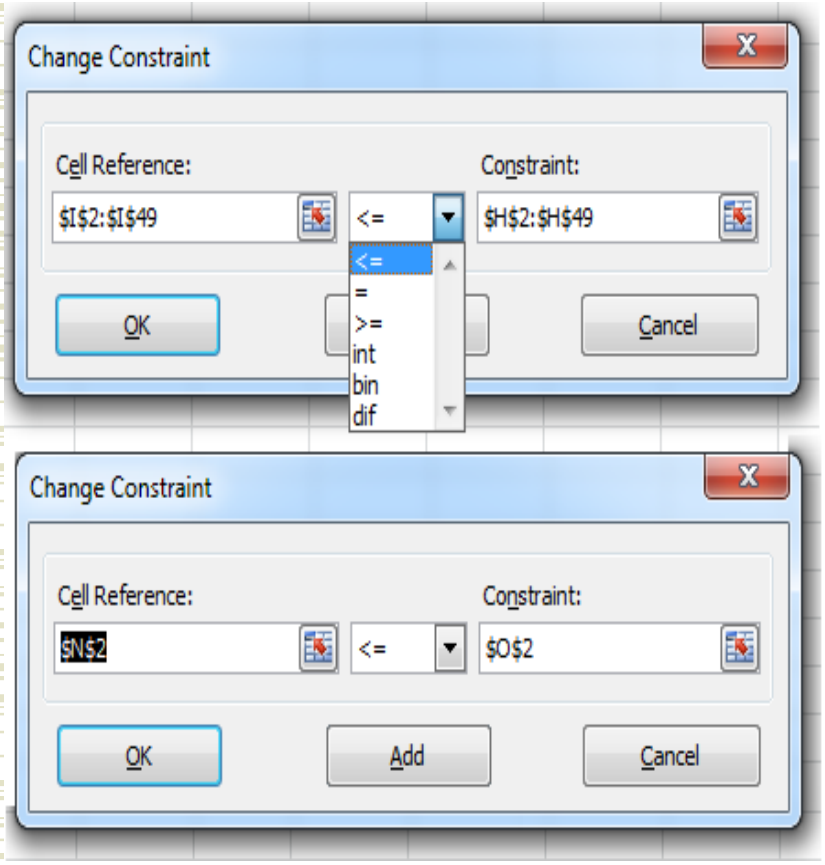
Setting up Constraints and Objective Function in Solver

- STEPS to add solver to Tools menu:
  1. Select: File ->Options -> Add-Ins
  2. From the dialog box, check the box for Solver Add-In
  3. Clicking OK
- The Solver Parameters Dialog Box



Setting up Constraints and Objective Function in Solver

- Adding Constraints with Solver

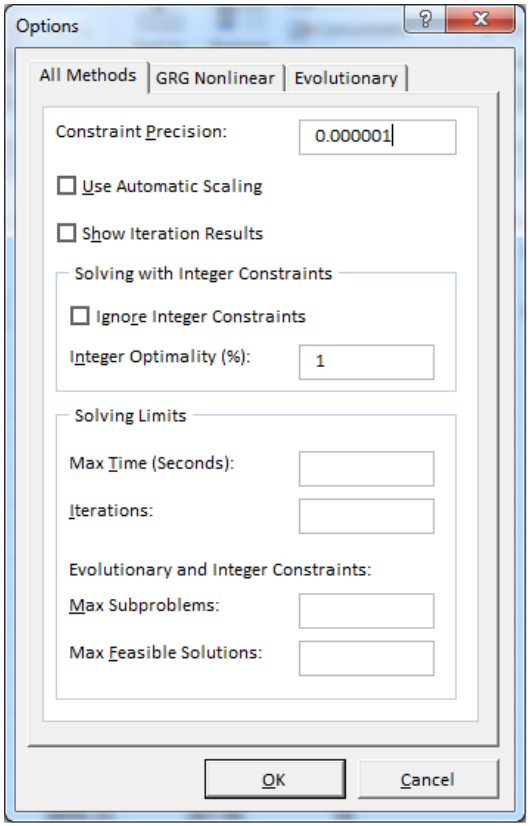


- <= when assigning a less than or equal to constraint
- = when assigning an equal to constraint
- >= when assigning a greater than or equal to constraint
- int when assigning an integer values to the left hand side cells
- bin when enforcing a binary {0, 1} value to the left hand side cells
- dif when enforcing a different values for each decision variable

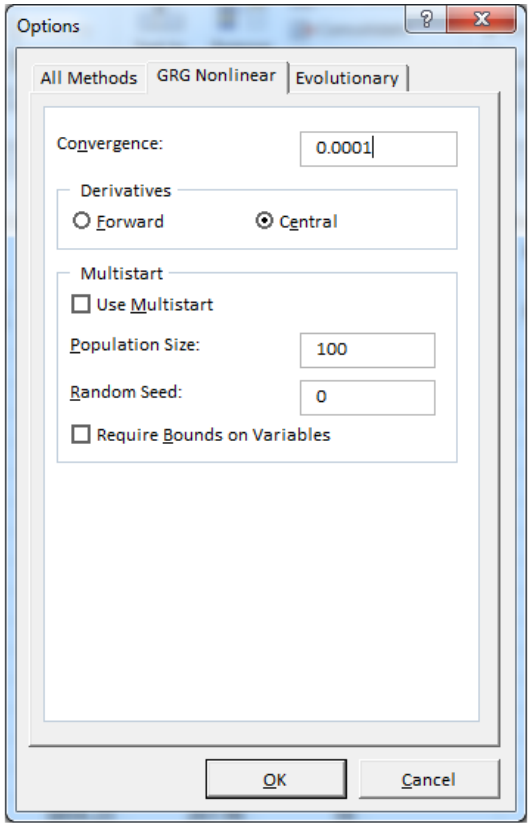
Selecting Solver Options

- Solver offers several options which reflect various assumptions that the analyst can make regarding the LP model.
  1. The first option is to enforce that the solution values for the decision variables remain positive or zero
  2. The next option is to choose between a different solution approaches: simplex LP, GRG non-linear, and evolutionary
  3. Further options can be explored when clicking the Option button
     - All Models
     - GRG nonlinear
     - Evolutionary

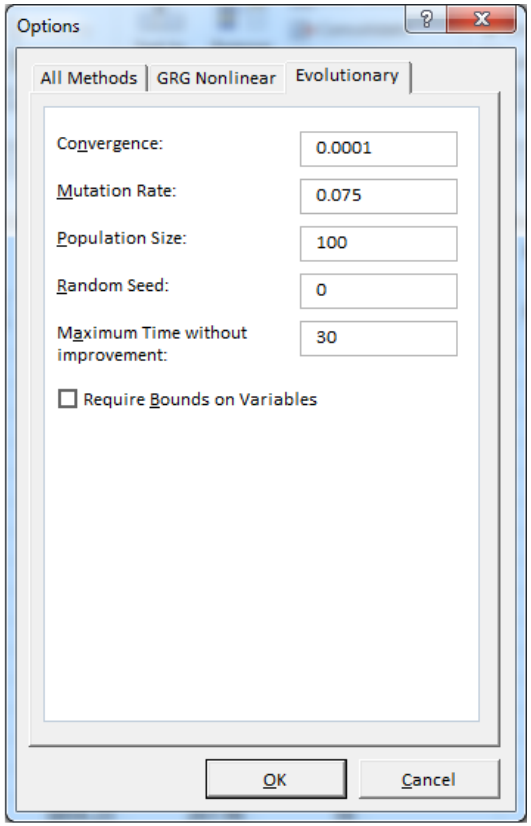
Further Options in Solver



a. Options for All Methods



b. Options for GRG Nonlinear Method



c. Options for Evolutionary Method

All Models Options

- The first Tab in the Options window can be used to select general options applicable to all types of solution methods.
- Constraint precision
  - To choose the degree of precision.
  - A specific degree indicates how much the relationship between the Cell Reference and the Constraint value can be violated.
  - The smaller the number, the higher the constrain precision.
- Use Automatic Scaling
  - To rescale the values of decision variables, constraints and the objective function to comparable magnitudes.
  - Allows for a reduction of the impact of extremely large or small values on the accuracy of the solution process

All Models Options

- Show Iteration Results
  - To see the results of each attempt to find a solution.
- Solving with Integer Constraints
  - The decision maker can select the *Ignore Integer Constraints* check box to relax such integer constraints.
  - The *Integer Optimality %* box can be used to set the maximum percentage difference between the objective value of the suggested solution and the true optimal objective value.
- Solving Limits
  - The decision maker can also choose the length of time, *Max Time (Seconds)* or the number of tries, *Iterations* that Solver must run until it stops

GRG Nonlinear Options

- The second Tab in the Options window can be used to select several options when the GRG Nonlinear solving method is used

- Convergence
  - The decision maker may consider stopping the Solver when there are no longer significant improvements in the value of object function as the iterations continue.
  - In this situation, the value entered in the *Convergence* box indicates the amount of relative change to be allowed in the last five iterations before Solver displays the “Solver converged to the current solution” message and stops further attempts.

GRG Nonlinear Options

Derivatives

- The nonlinear method uses the first derivatives to approximate a solution during any given iteration.
- *Forward differencing* is calculated as:

$$f'(x) \cong \frac{f(x+h) - f(x)}{h}$$

- *Central differencing* (more accurate) is calculated as:

$$f'(x) \cong \frac{f(x+h) - f(x-h)}{2h}$$

Multistart

- This allows Solver to simultaneously run several GRG method solutions each starting at different and arbitrary chosen points.

Evolutionary Options

- The third Tab in the Options window can be used to select several options when an evolutionary solving method is used.
- Evolutionary methods, such as genetic algorithms apply the principles of evolution found in nIn a nutshell, the evolutionary method consists of the following steps:
  1. Create an initial set of possible solutions (initial population) and calculate the value of the objective function for each member of the initial population
  2. Select several members with good value of the objective function and apply mutation or crossover operators to generate a new generation of solutions
  3. Continue step a and b until a satisfied solution is achieved

Evolutionary Options

- Convergence
  - The value entered in the Convergence box indicates the amount of relative change to be allowed in the last five iterations before Solver displays the “Solver converged to the current solution” message and stops further attempts.
- Mutation Rate
  - Indicates the portion of the members of a given population which are altered “mutated” to create a new trial solution, during each “generation.”
- Population Size
  - Indicates the number of members in the population, that is, the number of different points or values for the decision variables.

Evolutionary Options

- Random Seed
  - It is used to generate a random choice in the evolutionary method.
  - This box requires an integer value
- Maximum Time without Improvement
  - This box indicates the maximum number of seconds that the Evolutionary method continues without a meaningful improvement in the objective value
- Require Bounds on Variables
  - The Evolutionary method is more effective if upper and lower bounds on decision variables are defined.
  - The tighter the bounds on the variables that a decision maker can specify, the better the Evolutionary method is will perform.

Generate Solution