Bootstrapping Program Directions for www.r3eda.com
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Bootstrapping Program Directions

The Excel VBA file named “Bootstrapping w refraction w scaling 2015-09-03.xlsm” is my program for bootstrapping for a single-input-single-output (SISO) steady-state model (y=f(x)). To use it:

1. Enter your data in the yellow cells in Columns 17 & 18. The VBA array is dimensioned for up to 30 data sets. If you have more, you’ll need to change the DIM statement to increase the array size.
2. Sort your data on x-value for visual convenience when the modeled values are displayed.
3. Duplicate the sorted data in Columns 3 & 4. This is the field that will contain the realization sets. But, start it with your entire data set.
4. Enter your model in the VBA function "Model". I have set it up to use scaled variables in the model, scaled on the normal 0 to 1 range. The function reads the max and min values from the Excel worksheet calculation in cells (1,17) to (2,18). This makes it easier for Solver to find the solution, but it adds execution time in obtaining the values and scaling the variables. You do not need to use scaled variables.
5. Adjust the range in Columns 5-8 and 19 to match your data length. These calculate modeled values and the residuals for least squares minimization. I have the conventional vertical least squares as the objective function to be minimized.
6. Call Solver and set up coefficients in the blue cells (Column 5) for your model. I have it set up for solver to find 4 model coefficient values. If you have more or less you’ll need to change the range in the Solver “By changing variable cells” field. And change range in each of the three Solver calls in the VBA program. Edit the line *ByChange:="$E$3:$E$6"* to represent your coefficient range. The GRG (Generalized Reduced Gradient) optimizer that Solver uses is very good when the initial model coefficient values are in the vicinity of the optimum values; but, if initialized far from the optimum, the Newton’s aspect of the GRG can send it off to a ridiculous solution. So, your initialization of the model coefficient values might be important. This will be the nominal model, the one that is generated by all of your data.
7. Choose a number of Bootstrapping realizations, and enter that value in Cell (5,18). The VBA array is dimensioned for up to 500 realization sets. If you want more, you’ll need to change the DIM statement to increase the array size, and the range in the sigma calculation of Cell (5,25).
8. Press the "Bootstrapping" button.

The program will sample data from Columns 17 & 18 and generate a realization set in Columns 3 & 4. It will call Solver to find the optimum coefficient values for that realization. It then looks at the model values in Column 19, and if any one represents an extreme high or low it places those values in Columns 20 & 21. It displays the results after each realization. The left hand graph shows the realization data and the model. You can see the progressive evolution of the extreme values of the realizations as the red curve on the right hand graph. After all of the realizations, the VBA code replaces all of the original data set in the realization column and displays the nominal model. Then the VBA code sequentially lists all of the realization y-values in Column 25, for each data set. Excel calculates the sigma in the list. The VBA program uses that sigma from the modeled y-values to generate the 2-sigma range from the nominal model. This is displayed as the black curves in the right hand graph.