USING OPTQUEST

The OptQuest tool for Crystal Ball searches for optimal levels for a number of decision variables using performance measures and constraints from Monte Carlo simulations. For example, if a model simulates a distribution for "profits," OptQuest can compute the quantity of product to produce in order to maximize profit. Alternatively, OptQuest can be set to find solutions that minimize or limit other statistics as well, such as standard deviation or standard error.

To use OptQuest, follow these steps:

1. Define the decision variables for the model. Decision variables are the variables that OptQuest will determine. Define decision variables by using the decisions button or selecting Cell->Define Decision . . . on the menu. When setting the decision variables, input a lower and upper constraint. In addition, designate whether the variable is discrete or continuous.

2. Once your decision variables are defined, click on the OptQuest button with the Crystal Ball model open or select CBTools->OptQuest from the menu. This will launch the OptQuest application.

3. With OptQuest open, click the "new file" button or "open file" button to open an existing optimization file.

4. The OptQuest Wizard then launches, and shows the following successive dialog boxes:

   a. *Decision Variable Selection:* This dialog box allows users to choose which decision variables to include in the optimization, their ranges, and whether they are discrete or continuous.

   b. *Constraints:* Users can set constraints in this box for the simulation as a whole. These will be global constraints, such as the capacity of a factory or a minimum investment.

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c. *Forecast Selection:* In this box, users must specify the goal of their optimization. This can be the maximization or minimization of any of the forecast variables' means. Furthermore, users can set a minimum variance or standard deviation or any number of statistics for the forecast variables.

d. *Options:* Users have the ability to set run preferences specific to the manner in which OptQuest runs. These are described below.

5. When you have finished defining the simulation, OptQuest will run. The process can take from several minutes to hours, depending on how much you wish OptQuest to search. Note that the number of trials set in Crystal Ball's run preferences will be a primary driver of the length of time required.

Running OptQuest and Saving Results

Selecting objective forecast variables and requirements

You have several alternatives when selecting the objectives in OptQuest:

1. *Variable:* You should select one forecast variable as your objective variable.

2. *Statistic:* This is the statistic you wish to optimize. For example, you might be interested in maximizing a mean or minimizing variance.

3. *Requirements:* If any restrictions on the results exist, you can specify them here. For example, if you wish to maximize the mean of your forecast variable but are willing to accept only a given amount of variance, you can specify the maximum variance as a requirement. Note that if the requirement is on your objective variable, you will need to duplicate it in the list of forecast variables. To do so, select the variable, go to the Edit menu, and click "duplicate." For additional information on restrictions, see page 73 of OptQuest's user manual.

Options

The following are important options you should consider before running a simulation:

1. *Stochastic vs. deterministic simulation:* OptQuest offers two methods for finding an optimal solution, depending on the nature of your model. If your model has stochastic assumptions (assumptions that are randomly generated by Crystal Ball), you should select the stochastic option. Otherwise, OptQuest will find the optimal solution for the current value in your assumption cells.

2. *Tolerance:* The tolerance parameter allows OptQuest to avoid doing two simulations for very similar decision values. To determine whether a given set of decisions is equivalent to another one, OptQuest will multiply the range of possible values of each decision variable by the tolerance parameter, obtaining the tolerance range for each variable. Simulations where the difference between each decision variable is within the tolerance range are not performed.

3. *Confidence testing:* OptQuest may not run the total number of trials for a set of decision variables that are almost sure to be inferior to some set of decision variables that have already been run. When the neural-network option is on (advanced), it will evaluate the results obtained after some trials and will decide whether it is worth continuing with the current simulation. Keeping the neural network on can reduce the work needed to reach a good solution, but at the cost of possibly skipping an optimal solution.

4. *Trials:* The maximum number of trials that OptQuest will run for each trial is determined by your configuration of Crystal Ball. If you want to change the number of trials, go to Crystal Ball preferences and select the desired number of trials. In general, you will find a trade-off between time and accuracy: you can choose a high number of trials for each simulation that OptQuest evaluates. The higher the number of trials, the longer it will take OptQuest to perform a relevant number of simulations. The higher the number of trials, however, the tighter the confidence bands for each simulation.

5. *Saving options:* OptQuest offers three options to save the results of each simulation run: none, only best, all. If you choose "only best," OptQuest will save the run of the best simulation obtained. Likewise, if you choose "all," OptQuest will save all the Crystal Ball runs performed.

Saving results

OptQuest does not save the results from a given run; it saves only the settings of the optimization. Thus, if a user wishes to save the results from the optimization, it is necessary to perform the following:

1. *Log file:* You might want to save the log file, which contains a summary of the results of each simulation, like the mean and the standard deviation. To view the log file, click the log button , copy the text, and paste it into other applications.

2. *Performance graph:* The performance graph shows how the solution evolves as more simulations are done. It shows how fast, or slow, OptQuest found an optimal solution. You can copy the graph as any other object and paste it into other applications.

3.   *Runs:* OptQuest will save the best run or the runs that were best at any moment of the simulation (depending on what options you chose). To save the run, you should select it, click the Edit menu, and then select "Copy to Excel." This command will restore the Crystal Ball run. Then you can save the run in the same way you save other Crystal Ball runs.

A Simple Example

To illustrate how all these concepts can be used, consider an example: Dan runs a newspaper stand, and he is wondering how many newspapers he should order each morning. He sells the *Local Daily,* which costs him $0.45 each, and he then resells each copy for $0.65. At the end of the day, any newspapers left over are worthless. From tracking his past, he knows that the demand for the *Local Daily* is normally distributed, with a mean of 800 papers and a standard deviation of 100. He wants to order the right amount to maximize his mean profit.

We could determine Dan's optimal paper-order numbers with a data table and trial and error. Alternatively, OptQuest could automate the optimization process. This example is really too simple for OptQuest even though it illustrates how to use OptQuest; the power of OptQuest comes into play where there are many decision variables to be optimized, which could not be handled via data tables.

To solve this problem, perform the following steps:

1.   *Model the problem:* First, prepare a simple model with four cells:

        a. *Quantity purchased:* the number of papers Dan buys
        b. *Demand:* how many papers are demanded
        c. *Units sold:* the smaller of demand and quantity purchased
        d. *Profit:* units sold times the sale price ($0.65) minus quantity bought times unit cost ($0.45)

2.   *Define the variables:* Using the Crystal Ball, define the variables as follows:

        a. *Quantity purchased:* a decision variable, the minimum is 0 and is discrete, with steps of 1
        b. *Demand:* an assumption variable, defined with a normal distribution, with mean of 800 and standard deviation of 100
        c. *Profit:* a forecast variable, this is the value we are trying to maximize

3.   *Run OptQuest:* Once you run OptQuest, the following windows appear:

        a. *Decision Variable Selection:* Select quantity purchased, specify the minimum value as 0, the maximum as 2000, and define it as a discrete variable with steps of 1.

b. *Constraints:* There are no constraints in this example.
c. *Forecast Selection:* Select "Maximize Variable" for profit; the variable to maximize is the mean.
d. *Options:* Select the options according to your preference.

4. *Analyze the results:* When OptQuest completes the simulation, it will show the number of papers Dan should buy to maximize his profits.