Deterministic Sensitivity Analysis for First-Order Monte Carlo Simulations: A Technical Note

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ABSTRACT

Objectives: Monte Carlo microsimulations have gained increasing popularity in decision-analytic modeling because they can incorporate discrete events. Although deterministic sensitivity analyses are essential for interpretation of results, it remains difficult to combine these alongside Monte Carlo simulations in standard modeling packages without enormous time investment. Our purpose was to facilitate one-way deterministic sensitivity analysis of TreeAge Markov state-transition models requiring first-order Monte Carlo simulations.

Methods and Results: Using TreeAge Pro Suite 2007 and Microsoft Visual Basic for EXCEL, we constructed a generic script that enables one to perform automated deterministic one-way sensitivity analyses in EXCEL employing microsimulation models. In addition, we constructed a generic EXCEL-worksheet that allows for use of the script with little programming knowledge.

Conclusions: Linking TreeAge Pro Suite 2007 and Visual Basic enables the performance of deterministic sensitivity analyses of first-order Monte Carlo simulations. There are other potentially interesting applications for automated analysis.

Keywords: decision analysis model, Markov model, methods, microsimulation, modeling.

Background

In recent years, Monte Carlo microsimulations have become increasingly common in decision-analytic modeling [1]. This is largely because of the fact that drastically increased computer power has made it possible to perform microsimulations in reasonable amounts of time. Although parameter-uncertainty ("second-order" uncertainty) can be assessed using probabilistic sensitivity analysis [2], stochastic uncertainty is only considered "random noise from a decision maker's point of view, and can be overcome by increasing the sample size of the microsimulation" [3]. First-order Monte Carlo simulations employing "tracker variables" enable one to overcome the "memory-less" nature of Markov transition-state models without increasing the number of health states, thus avoiding potential sources for errors. In this way, discrete events can be incorporated into Markov models. Nevertheless, with a standard modeling package such as TreeAge Pro (TreeAge Software, Inc. Williamstown, MA, USA), it can be difficult to perform multiple deterministic sensitivity analyses, because each single data point requires that a new Monte Carlo microsimulation be performed, and thus huge investments of time have to be spared by the researcher. We therefore sought ways to automate deterministic one-way sensitivity analysis of models requiring the use of first-order Monte Carlo simulations.

Methods and Results

Using TreeAge Pro Suite 2007 and Microsoft Visual Basic for EXCEL (Microsoft Corporation, Redmond, WA, USA), we con-

Address correspondence to: Benjamin P. Geisler, Institute for Technology Assessment, Massachusetts General Hospital, 101 Merrimac St., Floor 10, Boston, MA 02114, USA. E-mail: ben@mgh-ita.org

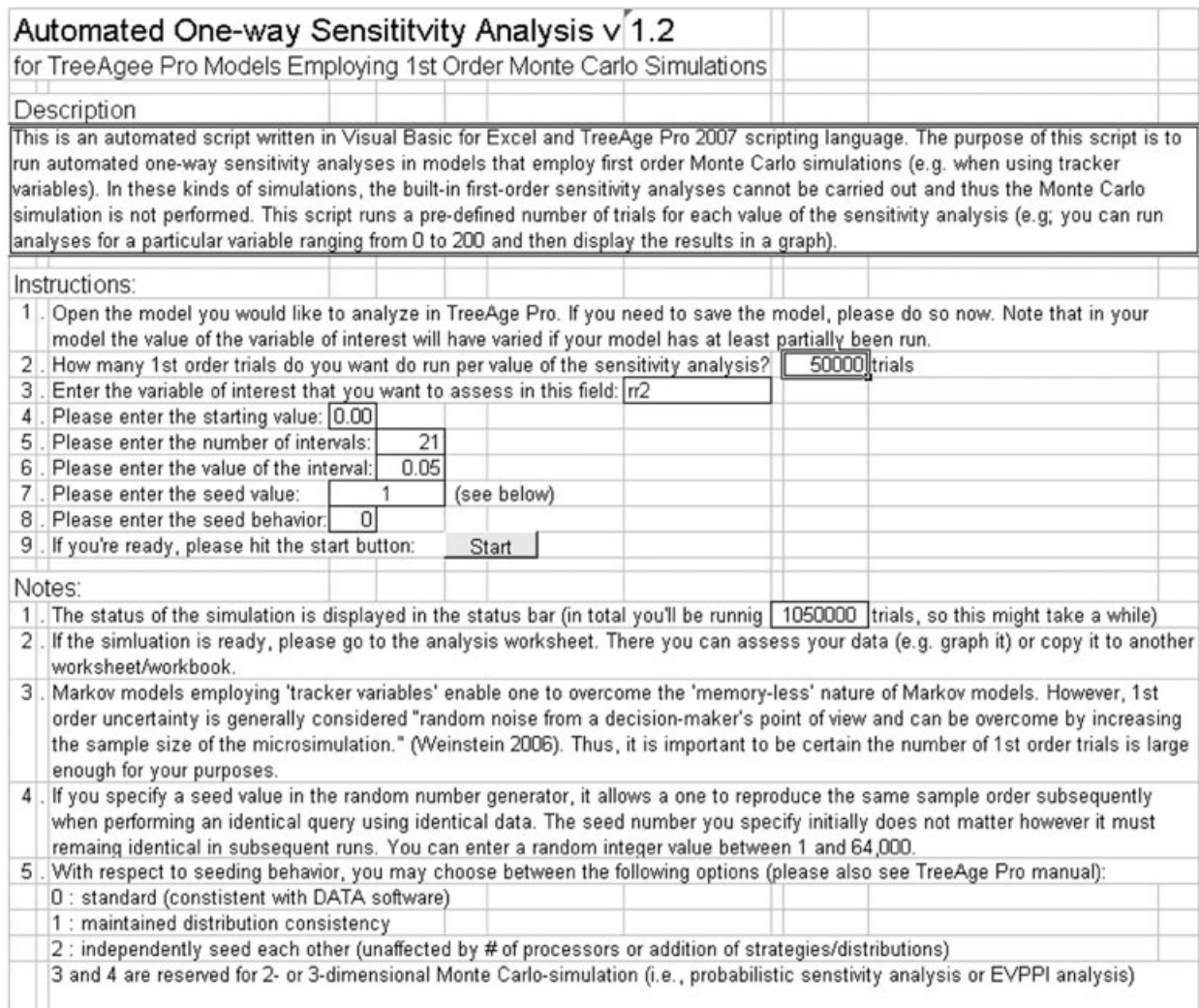structed a generic script that enables the performance of automated deterministic one-way sensitivity analyses in EXCEL employing microsimulation models. By using object-oriented programming, we accessed "TreeAgeProLib" objects of the TreeAge Pro EXCEL add-in to perform a specified number of first-order Monte Carlo simulations in EXCEL. Before the first-order Monte Carlo simulation was run, a variable of interest was set. After the simulation had finished, we output the costs and effectiveness per strategy and then computed the incremental costs, effectiveness, and cost-effectiveness ratios. These three operations were repeated in a "FOR . . . NEXT" loop to set the variable of interest to a value ranging from the lowest to the highest prespecified value of our deterministic one-way sensitivity analysis. The script that we used is included in the appendix. In addition, we constructed a generic worksheet in EXCEL (see Fig. 1) that allows for the use of the script without programming knowledge. The code and the spreadsheet are generic for all TreeAge models with two strategies and can be downloaded from our website, http://www.mgh-ita.org/index.php?option=com_content&task=view&id=163&Itemid=84.

Conclusions

Linking TreeAge Pro Suite 2007 and Visual Basic allows the automatic performance of multiple deterministic sensitivity analysis in first-order Monte Carlo simulations. Generic code can be run in convenient EXCEL spreadsheets with no programming knowledge necessary. There are other potentially interesting applications, such as automated sensitivity analysis of cohort models, automated deterministic two or multiway-sensitivity analyses of models depending on first-order Monte Carlo simulations, automated model calibration, and automated second-order Monte Carlo simulations, such as expected value of partial information analyses with varying sets of constant variables.

Figure 1 Screenshot of the Generic EXCEL User interface.

References

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