CONSIDERATIONS WITH REGARD TO INPUT VARIABLES FOR COMPUTER SIMULATIONS

Ronald L. Iman

Sandia National Laboratories
Albuquerque, New Mexico

ABSTRACT

Many different projects at Sandia National Laboratories use mathematical models to represent different physical processes which are then implemented on a computer. One such project is the development of a methodology to assess the risk associated with the geologic isolation of radioactive waste. Models are used for physical processes such as subsurface and surface transport of radionuclides, calculation of salt dissolution rates, flow rates, and thermomechanical properties. In another project, computer models of physical processes are use to assess the consequences of a severe accident at a nuclear reactor. In these applications as well as others, the models are mathematically complex, very time consuming to run, have many input variables (some of which may be correlated) and produce a time dependent output which is a nonlinear monotone function of the input.

In the model development phase it is desired to use only a few computer runs with limited data available and assess the influence of the input variables on the output and determine which ones are dominant. This reduces the complexity of the model thus allowing limited research funds to be concentrated of gathering data on the important variables. The sensitivity analysis techniques on which this simplification is based thus provides a means for the modeller to respond to questions from sponsoring agencies and reviewers about why certain variables were not included in the final model. After the models are developed it is necessary to run the coupled models in order to provide an estimate of the complementary distribution function of the output variable.

The above considerations make it clear that an analysis can only be meaningful if great care is given to the selection of specific values of input variables used on each of the runs with the computer model. In this paper the sampling procedure (3,4) for selecting the specific values of the input variables is explained along with a recently developed distribution free technique for correlating the input variables (1,2) in order to match a desired multivariate input structure. The usefulness of this technique lies not only in creating a correlated structure but also in the fact that it can be used to create nearly orthogonal input for Monte Carlo studies. This feature is particularly useful where only a small number of runs can be made. The rank correlation technique is demonstrated with a simple example and a textbook example is used to illustrate the bias involved when the multivariate structure of the input is ignored and all input variables are incorrectly assumed to behave independently of one another.

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