INTRODUCTORY REMARKS ON RELIABLE ENGINEERING COMPUTING

Ramon E. Moore

Worthington, Ohio
rmoore17@columbus.rr.com

Rafi Muhanna and Robert Mullen (Muhanna, R. L. and Mullen, R. L., Interval Methods for Reliable Computing, Chapter in Reliability Design Handbook, CRC Press LLC, ISBN 0-8493-1180-2, edited by Efsratios Nikolaidis and Dan Ghiocel, to be published February 2004) have identified four sources of uncertainties in physical system models:

1. The appropriateness of the mathematical model to describe the physical system
2. The discretization of the mathematical model into a computational framework
3. The inexact knowledge of input parameters of a problem
4. Errors introduced by the nature of computer finite arithmetic

Computational interval methods will be discussed for dealing with each of these sources of uncertainty.

More generally, interval arithmetic, which is very simple, is incorporated as a tool in more sophisticated methods for analyzing uncertainty in engineering design, when more information is available than simple upper and lower bounds on uncertainties of inputs. For example some recent works of Erik Antonsson and others use the “level interval algorithm”, which is itself used internally by their “Method of Imprecision”. There are frequent uses of interval arithmetic as a tool in such fuzzy systems analyses, see for example the special issue on Interfaces between Fuzzy Set Theory and Interval Analysis, of the journal Fuzzy Sets and Systems, Vol 135, No 1, April 2003. Interval arithmetic can also be used in probabilistic handling of uncertainty, see for example the two special issues of the journal Reliable Computing devoted to Dependable Reasoning about Uncertainty, guest-edited by D. Berleant, Vol 9, No.6, (Dec. 2003) and Vol 10, No. 2 (April 2004); and D. Berleant and J. Zhang, “Representation and problem solving with the distribution envelope determination (DEnv) method”, Reliability Engineering and System Safety, in press. By using step-function interval envelopes around probability density functions, we can sometimes compute useful envelopes for cumulative distributions without using costly Monte Carlo methods.