

Multi-Objective Generalized Sensitivity Analysis (MOGSA) - Luis A. Bastidas, Hoshin V. Gupta, and Soroosh Sorooshian

PUB-IAHS Workshop
Uncertainty Analysis in Environmental Modelling
 6th – 8th July 2004

a) Introduction:

The method is an extension of the "regional sensitivity analysis" (RSA) single-criterion method to handle multiple criteria. It begins with a uniform random sampling of n distinct points in the feasible parameter space Γ and proceeds by partitioning Γ into a region RB (called the "behavioral" region), which is characterized by a desirable modelled behaviour and its complement RB (called the "non-behavioral" region). The behavioural region must be defined in terms of a multi-criteria threshold and the Pareto rank concept is used to avoid scale dependency. The Kolmogorov-Smirnov (K-S) test is used to determine if the cumulative distributions are different (sensitive parameters). To ensure robustness and avoid sample dependency bootstrapping and the median of the K-S statistic are used. The procedure successively increases the sample size until the number of sensitive parameter stabilizes. Because the procedure could be dependent on the Pareto Rank chosen several at least five different ranks are tested.

b) Advantages

- Uses multiple-criteria, therefore includes more information (can combine different outputs and error functions simultaneously)
- Efficient and robust
- Incorporates parameter interaction
- Does not require parameter independence
- Bootstrapping avoids sample dependency
- Bootstrapping and median improve robustness
- Multiple criteria allows for larger number of parameters
- Quantification of parameter sensitivity level
- Handles internal (mechanistic) parameter constraints
- No scale or unit dependency
- Several thresholds considered, i.e. less subjectivity

c) Disadvantages

- Some level of subjectivity remains
- Not fully automatic
- Separate contribution to overall sensitivity not established
- Dependent on the bounds of the feasible parameter space
- Requires at least three criteria for proper work

d) Assumptions

Feasible parameter space properly established
 Bootstrapping overcomes sample dependency
 Median is the most robust statistic
 Significance level can be used as sensitivity measure

e) Most appropriate application areas

The methodology is not in itself a tool for uncertainty analysis; however, it may be used in conjunction with uncertainty analysis tools to reduce the dimensionality of the problems. It has been used successfully for highly parameterized models such as land surface parameterization schemes and hydrochemical and environmental models.

f) Reading list

Bastidas, L. A., H.V. Gupta, S. Sorooshian, W.J. Shuttleworth and Z.L. Yang "Sensitivity Analysis of a Land Surface Scheme using Multi-Criteria Methods", Journal of Geophysical Research, Vol. 104, No D16, p. 19,481-19,490, 1999.

Meixner, T., H. V. Gupta, L. A. Bastidas and R. C. Bales, The Use of Mass Flux or Concentration for Sensitivity Analysis of the Alpine Hydrochemical Model, Hydrological Processes, 13, pp. 2233-2244, 1999.

g) Software availability

Available from Luis A Bastidas – luis.bastidas@usu.edu

h) Web links or other information – none given

i) Figures

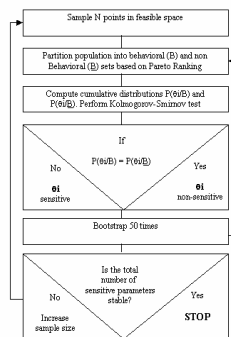


Figure 1: The MOGSA methodology

j) Delegates Comments (please add !!)