

Seminar on sensitivity analysis

Lamsid, 19 april 2010,

10h00 A tutorial on sensitivity analysis.
Stefano Tarantola, Institute for the Protection and Security of the Citizen, JRC
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11h00 Moment independent sensitivity analysis: theory and examples.
Emanuele Borgonovo, Department of Decision Sciences, Bocconi University
Milano

12h00 Questions and Discussions

LaMSID (<http://www.lamsid.cnrs-bellevue.fr>) is located at EDF R&D, Clamart
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TUTORIAL ON SENSITIVITY ANALYSIS

Stefano Tarantola – JRC Ispra

Sensitivity analysis is a statistical instrument for the analysis of simulation models (mathematical, numerical or statistical).

These latter usually contain parameters and other inputs whose values are known at a certain degree of uncertainty, due to the lack of scientific information. Those uncertainties can have more or less strong effects on the model predictions. It is interesting to investigate how the uncertainty of model predictions depends on the uncertainty of the parameters, in order to understand on which parameters one should intervene for reducing the uncertainty of model predictions below given limits.

Sensitivity analysis permits answering the following questions: what is the overall effect of input uncertainty on the model predictions; which are the inputs mostly responsible of this uncertainty; what is the effect on output uncertainty due to input interaction.

Sensitivity analysis is an essential statistical tool both for the modeler, who has to design and build the model, and for the analyst, who has to interpret the results. Sensitivity analysis helps understanding the modeling process and can highlight model weaknesses. Moreover, it helps the user (i.e. the decision-maker) to base decisions on more reliable predictions.

Searching on Science's after its last review of sensitivity analysis in 1989 (System analysis at molecular scale, by H. Rabitz) only very primitive sensitivity analysis tools are employed, based on "one-factor-at-a-time" (OAT) and "local" approaches, which work only for linear models. Considerable developments have taken place in this discipline in the last twenty years and guidelines for "global" sensitivity analysis have been issued in Europe and US. Such good practices are able to overcome OAT shortcomings and allow the concept of factors importance to be defined rigorously, thus making the factors' importance ranking univocal.

We analyse the requirements of sensitivity analysis in the context of modelling, and present best available practices.

MOMENT INDEPENDENT SENSITIVITY ANALYSIS: THEORY AND EXAMPLES

E. Borgonovo, Ph.D.
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Moment independent sensitivity analysis methods allow one to assess the importance of a random variable without reliance on a particular moment of the output distribution. In this respect, they are better suited than variance-based methods in addressing the decision-maker/analyst's degree of belief and state of information about the uncertain model inputs and output. The associated sensitivity measures, δ -importance, shares interesting properties as normalization and invariance for monotonic transformation of the model output. In this seminar, we are going to provide a comprehensive overview of moment independent sensitivity analysis, both from its theoretical and practical viewpoints, illustrating the definitions, properties and some recent results that allow one to obtain the importance measures analytically. We will also discuss the information that one obtains by moment independent sensitivity measures and variance based measures, compare the respective insights and show that their joint utilization provides analysts with a full-fledged analysis of uncertainty and a thorough indication of the most important factors in the problem.