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## Chapter 1 : Sensitivity analysis - Wikipedia

*Uncertainty Analysis with High Dimensional Dependence Modelling offers a comprehensive exploration of a new emerging field. It will prove an invaluable text for researches, practitioners and graduate students in areas ranging from statistics and engineering to reliability and environmetrics.*

Environmental[ edit ] Environmental computer models are increasingly used in a wide variety of studies and applications. For example, global climate models are used for both short-term weather forecasts and long-term climate change. Moreover, computer models are increasingly used for environmental decision-making at a local scale, for example for assessing the impact of a waste water treatment plant on a river flow, or for assessing the behavior and life-length of bio-filters for contaminated waste water. In both cases sensitivity analysis may help to understand the contribution of the various sources of uncertainty to the model output uncertainty and the system performance in general. In these cases, depending on model complexity, different sampling strategies may be advisable and traditional sensitivity indices have to be generalized to cover multiple model outputs, [48] heteroskedastic effects and correlated inputs. On the other hand, some quantities have no influence on the predictions, so that we can save resources at no loss in accuracy by relaxing some of the conditions. Additionally to the general motivations listed above, sensitivity analysis can help in a variety of other circumstances specific to business: To identify critical assumptions or compare alternative model structures To guide future data collections To optimize the tolerance of manufactured parts in terms of the uncertainty in the parameters To optimize resources allocation However, there are also some problems associated with sensitivity analysis in the business context: Variables are often interdependent correlated , which makes examining each variable individually unrealistic. Assigning a maximum and minimum or optimistic and pessimistic value is open to subjective interpretation. This sort of subjectivity can adversely affect the accuracy and overall objectivity of the analysis. Social sciences[ edit ] Sensitivity analysis is common practice in social sciences. A famous early example is Mroz , who analysed econometric models of female labor market participation. Sensitivity analysis can also be used in model-based policy assessment studies. Chemistry[ edit ] Sensitivity analysis is common in many areas of physics and chemistry. A kinetic model is usually described by a set of differential equations representing the concentration-time relationship. Sensitivity analysis has been proven to be a powerful tool to investigate a complex kinetic model. Sensitivity analysis can be used for optimal experimental design , e. A great number of parameters in a complex model can be candidates for estimation but not all are estimable. Sensitivity analysis can also be used to identify the redundant species and reactions allowing model reduction. Engineering[ edit ] Modern engineering design makes extensive use of computer models to test designs before they are manufactured. Sensitivity analysis allows designers to assess the effects and sources of uncertainties, in the interest of building robust models. Common examples are large trials only, higher quality trials only, and more recent trials only. If results are consistent it provides stronger evidence of an effect and of generalizability. For instance, the field of multi-criteria decision making MCDM studies among other topics the problem of how to select the best alternative among a number of competing alternatives. This is an important task in decision making. In such a setting each alternative is described in terms of a set of evaluative criteria. These criteria are associated with weights of importance. Intuitively, one may think that the larger the weight for a criterion is, the more critical that criterion should be. However, this may not be the case. It is important to distinguish here the notion of criticality with that of importance. By critical, we mean that a criterion with small change as a percentage in its weight, may cause a significant change of the final solution. It is possible criteria with rather small weights of importance i. This, in turn, may dramatically improve the effectiveness of the initial study and assist in the successful implementation of the final solution. Time-critical decision making[ edit ] See also: Window of opportunity Producing time-critical accurate knowledge about the state of a system effect under computational and data acquisition cause constraints is a major challenge, especially if the knowledge required is critical to

the system operation where the safety of operators or integrity of costly equipment is at stake, e. Understanding and interpreting, a chain of interrelated events, predicted or unpredicted, that may or may not result in a specific state of the system, is the core challenge of this research. Sensitivity analysis may be used to identify which set of input data signals has a significant impact on the set of system state information i. Through a cause-effect analysis technique, sensitivity can be used to support the filtering of unsolicited data to reduce the communication and computational capabilities of a standard supervisory control and data acquisition system. That is, one can seek to understand what observations measurements of dependent variables are most and least important to model inputs parameters representing system characteristics or excitation , what model inputs are most and least important to predictions or forecasts, and what observations are most and least important to the predictions and forecasts. Often the results are surprising, lead to finding problems in the data or model development, and fixing the problems. This leads to better models. Sensitivity auditing It may happen that a sensitivity analysis of a model-based study is meant to underpin an inference, and to certify its robustness, in a context where the inference feeds into a policy or decision making process. In these cases the framing of the analysis itself, its institutional context, and the motivations of its author may become a matter of great importance, and a pure sensitivity analysis â€" with its emphasis on parametric uncertainty â€" may be seen as insufficient. Most often the framing includes more or less implicit assumptions, which could be political e. In order to take these concerns into due consideration the instruments of SA have been extended to provide an assessment of the entire knowledge and model generating process. Likewise, sensitivity auditing has been developed to provide pedigrees of models and model-based inferences. The problem setting in sensitivity analysis also has strong similarities with the field of design of experiments. In sensitivity analysis one looks at the effect of varying the inputs of a mathematical model on the output of the model itself. In both disciplines one strives to obtain information from the system with a minimum of physical or numerical experiments.

## Chapter 2 : Dorota Kurowicka (Author of Uncertainty Analysis with High Dimensional Dependence Modelli

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