Post-doctorate position at IFPEN (France) : Sensitivity analysis and design of experiments for the statistical calibration of a physical model.

Lieu :

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Context:

The post-doctoral position is proposed in the framework of a transverse activity project dealing with a large panel of industrial problems where fitted models on data (experimental or simulated, dependent or not) are common. The post-doctorate will gravitate around one main application which concerns the atmospheric gas-oil hydro-treatment. Nevertheless the methodology to be developed is expected to be transversal and might be further applied at IFPEN in applications such as wind and marine turbines design or electrical motors optimization. In this context, in order to fit a given physical model to experimental data in an optimal way, a particular attention is required on the selection of the experimental points. Also, in order to better understand the input/output interactions and potentially alleviate the model, a sensitivity analysis taking into account the dependency of the loads need to be carried out. These two topics are the core of the post-doctoral study.

Study description and aim:

Sensitivity Analysis (SA) aims at quantifying the uncertainty in an input-output model. The objective is to identify and to rank the input variables that drive the uncertainty of the model output. SA objective is to reduce the model dimension and/or to detect the most influential parameters. More precisely, global SA is a stochastic approach based on the joint probability distribution function of the outputs and the inputs of a given model.
In this context, a subject of interest is the comprehensive definition and analysis of sensitivity indicators when random inputs are dependent. This subject has been increasingly studied the last fifteen years but the task is still complex and many indicators definitions have been proposed. Their interpretation remains a tricky problem as well as their estimation.
The main aim of the study is to evaluate and improve the standard methodologies used for sensitivity analysis with dependent data. The goal is to go beyond the common practice in which the problem is generally simplified by assuming the random input independency.

A second topic is the optimal choice of an experimental design in order to fit as best as possible a given parametric model. Beyond the common methodologies, difficulties arise when models are non-linear or/and when the outputs are vectorial. Non-linear models are commonly tackled with local (linearization) and sequential strategies but no certainty on the optimality of the resulting designs is ensured. The goal is here to assimilate the existing strategies and propose for a non-local one potentially enabling to deal with vectorial model outputs. The treatment of this topic will depend on the time available after progressing on the SA study.

In conclusion, this subject involves a cross-disciplinary topical issue which represents a challenge for the development of a large range of IFPEN group applications such as the efficient gas-oil treatment processes.

Candidate profile and expected work:

The candidate should have a PhD in applied mathematics, in the field of statistic or/and probability, with a strong expertise in uncertainty quantification and programming (R/Matlab). She/he must be independent and pragmatic. She/he must be open-minded and able to interact with the chemist experts on the gas-oil hydro-treatment application.

The applicant will analyze, implement and compare different approaches for the global sensitivity analysis of dependent random inputs (and optimal design of experiments). He will characterize the limitations of the above methods and open new perspectives.