Sensitivity analysis for optimization problems under uncertainties

Among IFPEN applications, finding the optimal configuration of the inputs of a model leading to the best admissible performance appears in the design of complex systems such as electric motors or floating wind turbines. Among the numerous inputs of this problem, a certain number is defined as uncertain or random, such as wind information or the characteristics of a material that is poorly controlled and subject to a certain tolerance.

This problem is formally translated as a constrained optimization problem with two types of variables: controllable design variables and random variables. Some constraints correspond to the feasible failure probability for the system to be designed.

Typically, these applications incorporate a large number of inputs that make the resolution of this problem non-trivial especially in the context of optimization coupled with computationally expensive simulators. In order to overcome this complexity, the classic strategy is to return to simpler models by reducing the size of the inputs. We focus on the sensitivity analysis method that characterizes the global influence of an input parameter on the variability of a certain quantity of interest of the outputs.

The objective of this thesis is to develop methods to identify the influential variables with respect to the considered problem, namely which are the controlled inputs that have a measurable impact on the performance of our model (relevant values of the cost function) but also those that lead to respect the constraints in a reliable way. In the same way, it seems relevant to be able to discriminate which are the random inputs that do not negatively impact the robustness or the obtaining of an optimal solution in order to simplify the initial problem.