INSTITUT PASCAL (UMR6602 UCA/CNRS) - Group PHOTON/CEM and laboratory XLIM/Systèmes RF-CEM et Diffraction

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Thesis subject: Machine learning approaches for uncertainty quantification due to numerical simulation process of Electromagnetic Compatibility problems

Short description
The context is that of the estimation of uncertainties on currents and electromagnetic fields obtained by deterministic computer codes. The sources of errors on the observables are linked either to the uncertainties of the physical or electrical input parameters (dimensions, characteristics of the materials, etc.), or to characteristics specific to the numerical codes used (discretization, limitations of the models, etc.). In this second case, there are very few works to estimate the propagation of this type of uncertainty. The objective is to efficiently and accurately obtain confidence intervals of the observables of interest according to the characteristics of the numerical schemes used.

Objectives
The prediction of the levels of interference induced on electronic systems or equipment is increasingly carried out by simulation. Indeed, on the one hand, experimentation is expensive and simulation software has reached maturity to represent complex systems. However, the system certification phases require the certainty that these coupling levels are below a model defined by the standards. Therefore, a deterministic simulation is not sufficient to meet this constraint. Indeed, the simulation results present errors related to two major types of factors: The geometric or physical characteristics of the objects represented are not known with infinite precision, and moreover the fact of discretizing and representing the objects by models often simplifies reality, which is a source of intrinsic errors in the calculation. Thus, the objective will initially be to become familiar with methods for calculating uncertainties, propagation of uncertainties and sensitivity analysis methods. These techniques will then be applied in the field of Electromagnetic Compatibility. Ultimately, the introduction of error bars in the simulations should make it possible to answer the problem.

Main steps
- Familiarization with mathematical techniques for uncertainty management. This part will be the occasion for the candidate to draw up a state of the art of the potential techniques, to assess their advantages, disadvantages and field of application.
- know how to build a simulation case and list the uncertain parameters that can be the cause of errors on the observables.
- Apply the uncertainty propagation approach on a case that will be defined and analyze the uncertainties on the currents or electromagnetic fields according to the exogenous and endogenous uncertainties.

Expected skills of the applicant
• Wave propagation, applied mathematics and numerical analysis
• Knowledge of probability and statistics.
• Mastery of programming languages (R language, python or Matlab)