Introduction to Uncertainty Quantification for Radar Numerical Simulation

RadarConf24, Rennes, Tutorial Session

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Description

Dive into the fascinating world of uncertainty with our comprehensive 3-hour tutorial that will unravel the mysteries behind uncertainties in numerical simulations! Whether you are a seasoned expert or a curious learner, our session promises to enhance your understanding with a blend of intuitive approaches, specialized vocabulary, and theoretical frameworks.

The tutorial will begin with an intuitive approach to the concept of uncertainty, easing you into the subject with relatable examples. We will then delve into the specialized vocabulary that provides the backbone for discussing and understanding uncertainty in various contexts.

Our journey will take a deep dive into modeling uncertainties, where you will learn the theory before applying it to real-world scenarios with practical examples from radar technology. This approach bridges the gap between abstract concepts and tangible applications, ensuring you can apply what you learn immediately.

After a well-deserved break, we will explore the propagation of uncertainties. You will learn how uncertainty in about input parameters can affect the results of the simulation, again supported by theory and practical radar cases. This knowledge is vital for anyone looking to master the impact of uncertainties in their field.

We will also examine the sensitivity to uncertainties, understanding how to quantify the importance of each input parameters, and we will anchor this knowledge with more practical radar examples.

Finally, we will address how to calibrate parametric simulation models and processes to minimize uncertainties, increasing accuracy and reliability in your work. By the end of the lecture, you will not only be well-versed in the theory but also equipped with practical strategies for reducing uncertainty in your projects.

In addition, don’t miss out on our special bonus section: "Case Study with Persalys." Persalys offers a user-friendly graphical interface to the powerful OpenTURNS software, designed for uncertainty quantification in Python. This unique opportunity to interact with Persalys is the perfect complement to the theoretical and practical insights you will gain throughout the lecture.

Join us for this enlightening tutorial and turn the tides of uncertainty to your advantage. Secure your spot now and prepare to engage with uncertainty. For sure, you will not regret it!

Intended Audience

This tutorial is dedicated for the inquisitive minds of engineers, researchers, graduate students, and professors, seeking to stay at the forefront of their disciplines.

Learning outcome

You will leave this tutorial not just with theoretical knowledge, but with the practical know-how to apply these concepts directly to real-world problems using a state-of-the-art, and free, software.

Prerequisites

No strong theoretical background is required for this introductory tutorial; however, a basic understanding of mathematics and Python coding is expected. Additionally, participants are strongly encouraged to bring their own personal laptops in order to actively engage with the provided Python code during the session.

Presentation Materials

This tutorial material will include PowerPoint slides and example Python source code.

Biography

Thomas obtained his master's degree in engineering from INSA Rennes in 2016 and completed his PhD in 2019. His thesis, funded by the CEA-DAM, focused on uncertainty propagation for Electromagnetic Compatibility (EMC) applications. Between 2020 and 2021, he worked as a research engineer within the EMC research team at IRT Saint-Exupery in Toulouse, working on stochastic modeling to reduce cross-talk uncertainty. In 2021, Thomas joined ONERA in the Radar and Electromagnetic Department as a senior research engineer. There, he is still focusing on quantifying uncertainties in electromagnetic simulations, particularly for the EMPRISE® software, which simulates complex radar systems within very large and complex radar scenes.

Personal bibliography

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[2] T. Houret, O. Lévêque, F. Mbow, N. Trouvé, X. Husson, A. Jouadé, "Comparison of Indirect Surrogate Models in a Very Large Scene SAR Simulator for Uncertainty Propagation", European Conference on Synthetic Aperture Radar, Munich, Germany, 2024.

[3] T. Houret, O. Lévêque, N. Trouvé, R. Bocheux, X. Husson, A. Jouadé, "Calibration of a Radar Material Cross-section Model using a surrogate Model Optimization Algorithm", *IEEE International Radar Conference*, Sydney, Australia, 2023.

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[5] T. Houret, P. Besnier, S. Vauchamp, P. Pouliguen, "Kriging in addition to controlled Stratification: Practical Implementation for Extreme Quantile Estimation in EMC Risk Analysis," *IEEE Access Journal*, 2019.

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