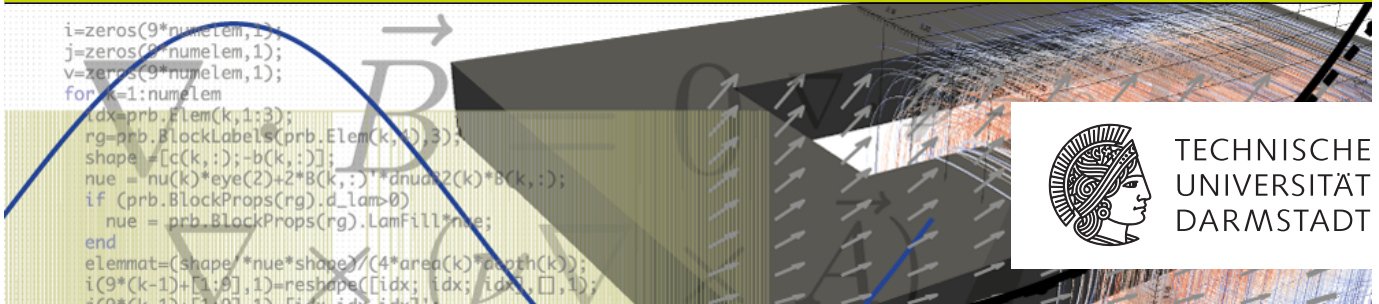


# Adjoint-based Adaptivity for Uncertain HF Problems

## Master Thesis

Computational Engineering / Electrical Engineering

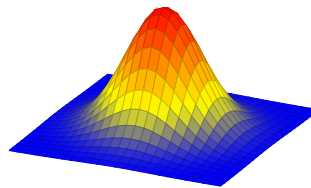
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## Motivation

In practice, the manufacturing process of electromagnetic components introduces small variations which usually can only be described statistically. Therefore, Uncertainty Quantification (UQ) aims for realistic predictions by describing the input data of numerical simulations, i.e. geometry and material parameters, as well as output data as random variables. An efficient method to compute statistical information about the output data, i.e. the quantities of interest, relies on spectral polynomial approximations of the mapping from inputs to outputs (generalized Polynomial Chaos). However, problems with many uncertain input parameters still pose a computational challenge. Due to the so-called *curse-of-dimensionality*, the computational cost grows rapidly with respect to the number of parameters.

The focus of this work is the *adaptive* construction of the polynomial surrogate model in order to mitigate the *curse-of-dimensionality*. The efficiency of this approach shall be further improved by employing adjoint-based error measures. The algorithm will be tested on high-frequency electromagnetic problems.



## Tasks

- Literature study on generalized Polynomial Chaos and sparse quadratures
- Implementation of adaptive pseudo-spectral projection algorithm
- Incorporation of an adjoint-based error indicator to steer adaptivity
- Application to real-world finite element models and investigation of efficiency
- Possible extensions: Sobol decomposition of error indicator, comparison of local and global error indicators; finite element modeling of a split-ring resonator; robust and smooth mesh deformation

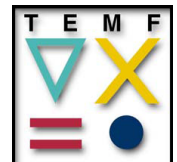
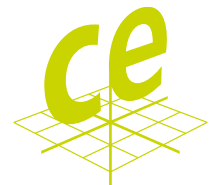
## Prerequisites

- Basic knowledge of or interest in Maxwell's equations and numerical methods
- Experience with programming languages such as Python or Matlab/Octave



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