DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE
UNIVERSITY OF SOUTHERN DENMARK, ODENSE

# Mathematics seminar

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# Reduced and surrogate models, computer experiments and the space of subspaces

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## U148

**Abstract**

High-fidelity numerical simulation of real-life processes usually results in nonlinear large-scale problems featuring up to several tens of millions of degrees of freedom. Despite today's impressive high-performance computing resources, there remain many time-critical applications in science and engineering, where an extensive use of such highly accurate numerical methods is prohibitive due to the associated computational costs. This fact triggers the need for very fast emulators of the high-fidelity simulators in question. In the following, such emulators are referred to as surrogate models, if they replace multiple-input-single-output systems, or as reduced models, if they replace multiple-input-multiple-output systems.
In this talk, I give an overview of my research in both surrogate and reduced modeling. Special focus is laid on non-intrusive methods, i.e. methods that do not require intrinsic modifications to the given high-fidelity model. This feature makes non-intrusive approaches highly attractive for industrial applications since they can be easily combined with commercial software.
The first part of the talk deals with surrogate modeling approaches based on spatial Gaussian processes, which also go by the name of Kriging. I present applications of variable-fidelity Kriging as well as theoretical results on the maximum-likelihood training of gradient-enhanced Kriging predictors and on the condition number anomaly of Gaussian correlation matrices.
The second part of the talk is concerned with parametric and adaptive nonlinear model reduction. I introduce an original approach for the reduced modeling of transonic CFD problems based on manifold learning. Moreover, I will outline a method for geometrically adapting subspaces in the context of projection-based model reduction. This requires the efficient numerically treatment of a nonlinear optimization problem on the Grassmann manifold of subspaces of a certain fixed dimension.

**Host: Achim Schroll**