



**MATH-IMS Joint Applied Mathematics Colloquium Series**  
**The Chinese University of Hong Kong**

*This MATH-IMS Joint Colloquium Series is organized by Center for Mathematical Artificial Intelligence (CMAI), under Department of Mathematics and Institute of Mathematical Sciences (IMS) at The Chinese University of Hong Kong. The colloquium series focuses on mathematics and applications of artificial intelligence, big data and related topics.*

**Date:** Dec 9, 2022 (Friday)

**Time:** 16:00-17:00 (Hong Kong Time)

**Zoom Link:** <https://cuhk.zoom.us/j/92775210812>

**Normalizing Flows for Learning from Few Images**

***Speaker: Professor Gabriele Steidl***

***Technische Universität Berlin***

**Abstract:** Learning neural networks using only a small amount of data is an important ongoing research topic with tremendous potential for applications. We introduce a regularizer for the variational modeling of inverse problems in imaging based on normalizing flows, called patchNR. It involves a normalizing flow learned on patches of very few images. The subsequent reconstruction method is completely unsupervised and the same regularizer can be used for different forward operators acting on the same class of images. By investigating the distribution of patches versus those of the whole image class, we prove that our variational model is indeed a MAP approach. Numerical examples for low-dose CT, limited-angle CT and superresolution of material images demonstrate that our method provides high quality results among unsupervised methods, but requires only very few data. Further, the approach also works if only the low resolution image is available. In the second part of my talk I will generalize normalizing flows to improve their expressivity. Pairs of Markov chains appear to be a unified framework to handle powerful generative approaches as stochastic normalizing flows, diffusion flows and variational autoencoders. The Markov chains point of view enables us to couple both deterministic layers as invertible neural networks and stochastic layers as Metropolis-Hasting layers, Langevin layers, variational autoencoders and diffusion flows in a mathematically sound way.

**Bio:** Professor Gabriele Steidl is a German mathematician whose research interests include computational harmonic analysis, convex optimization, image processing and machine learning. She is a professor of mathematics at the Technical University of Berlin. Prof. Steidl received her PhD and Habilitation in Mathematics from the University of Rostock, in 1988 and 1991, respectively. She became an assistant professor at Technische Universität Darmstadt in 1993, then moved to the University of Mannheim as a professor in 1996, and moved to the Technical University of Kaiserslautern in 2011, before taking her present position at the Technical University of Berlin in 2020. Among her many recognitions, she is an SIAM Fellow 2022, in the scientific advisory committee of the Helmholtz imaging platform of the Helmholtz association, member of the executive board of the MATH+ Excellence Cluster, program director of SIAG-IS (SIAM) until 2022, member of the DFG Fachkollegium Mathematik since 2020. Besides mentoring many students and leading projects, she has been served as editor-in-chief of the SIAM Journal on Imaging Sciences, Member of the editorial board of Journal of Mathematical Imaging and Vision, Inverse Problems and Imaging, Journal of Optimization Theory and Applications, Acta Applicandae Mathematicae (ACAP), etc.