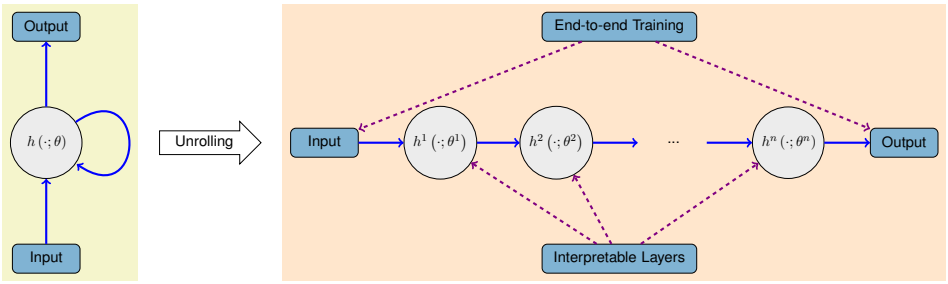
Doctoral Position in Mathematical Signal Processing

in DFG Collaborative Research Centre 1481 “Sparsity and Singular Structures”

CRC 1394 studies the mathematical foundations for computational approaches in machine learning, signal processing and simulation. Despite vast gains in the speed of computers, the deluge of data and complexity of models describing natural and technical phenomena pose fundamental challenges that cannot be surmounted by computational power alone. Two critical fronts for which the time is ripe to make progress are

1. signal processing and machine learning with huge data sets and;
2. partial differential equations with singularities such as point defects or interfaces.

The advertised position is associated with the project *A08 Sparse exit wave reconstruction via deep unfolding* and advised by Prof. Benjamin Berkels at RWTH Aachen. Deep unfolding is a technique that allows to introduce data-driven learning to a large class of classical iterative model-based approaches, creating new hybrid methods. Here, a fixed number of iterations is considered and each iteration is modelled as layer in a neural network. This leads to new network architectures that are still closely linked to the original model-based approaches. However, parameters or even components of the original iterative scheme can now be interpreted as parameters of the network and thus learned using training data.



In this project, we will revisit exit wave reconstruction, a problem that appears in electron microscopy where the complex-valued exit wave has to be inferred from real-valued measurements and that is a variant of phase retrieval. The goal is to introduce new hybrid models for variational exit wave reconstruction using deep unfolding and to understand their behavior, for instance, in form of their generalization properties by deriving bounds on the generalization error of these network architectures. We will systematically explore which parameters of the resulting networks are most beneficial for learning, considering different variants of the data term and both the case without regularizer and the case with a sparsity inducing regularizer like the 1-norm. For the case without regularizer, the question arises whether convergence guarantees of Wirtinger flow can be transferred to the trained hybrid models.

Your profile: We are seeking highly motivated candidates with strong mathematical skills. Requirement for this position is a master’s or equivalent degree in mathematics or a related field with a superior academic record. Knowledge in signal/image processing, optimization and/or data analysis is desired. Programming experience is of advantage. Excellent written and spoken English language skills are required.

Our offer: The candidate will be a regular employee and must meet required personal qualifications. This is a 75% position with a civil service pay scale TV-L E 13. The expected appointment period is **three years**. Full involvement in the CRC activities, including colloquia, annual schools and short courses is expected. Applications are being reviewed now.

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Starting date: at the next possible date

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