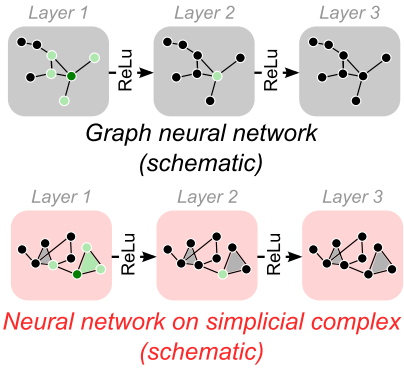
Postdoctoral / Doctoral Position in Signal Processing on Graphs
In DFG Collaborative Research Centre (CRC) 1481 “Sparsity and Singular Structures”

Context - 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 specific challenges the CRC will focus on are:

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

Project - The advertised position is associated with the project A07 “Signal processing on graphs and complexes” and advised by Prof. Michael Schaub at RWTH Aachen University.



Graph Signal Processing (GSP) has become a fast-growing area at the interface of machine learning, signal processing and applied mathematics. GSP aims to translate ideas from classical signal processing to data supported on graphs and manifolds. Such data arise in several applications, including the analysis of social networks, biomolecules, traffic networks, or for analysing data defined on a discretized space. To process such data, graph neural networks (GNNs) have gained interest in the last years. These GNNs are the backbone of geometric deep learning, a recent learning paradigm that aims to translate the success of deep learning to data on non-Euclidean domains.

Key to the development of GSP and geometric deep learning has been the translation of concepts from signal processing such as convolutions or Fourier transforms to signals supported on graphs, for which the (spectral) structure of the graph can be utilized. Recently, these ideas have been extended even further to data supported on general (discrete) topological spaces described by simplicial complexes However, while GNNs have shown excellent results for application in computational chemistry, physics, traffic prediction or combinatorial optimization, the mathematical foundations of GNNs are still not well understood — even less than those of classical deep learning methods that have become standard tools to solve problems in many domains such as computer vision, image processing, etc.

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The goal of this project is to advance our understanding of GNNs and related signal processing methods for data defined on non-Euclidean domains from a mathematical perspective. Our focus will be on (deep) learning architectures defined on graphs and simplicial complexes. Within this broad area we plan to use tools from dynamical systems, control theory, and graph theory, to explore two selected facets:

A) how the structure of the domain on which the neural network is defined constrains its expressibility, and
B) how the structure of the neural network influences its training via gradient descent and related algorithms. In both cases we will concentrate on the role of topological symmetries and the effect of (approximate) low rank structure within those networks, i.e., the role of inherent low-dimensional (sparse) substructures within these networks.

Your profile - We are seeking highly motivated candidates with strong mathematical skills and good programming knowledge. Requirement for this position is a PhD degree in mathematics or a related field with a strong academic record. In exceptional cases we will also consider candidates for a PhD position. Knowledge in signal/image processing, optimization and/or data analysis is desired. 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 100% 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 on a rolling basis, with a starting date as soon as possible

Contact

Michael Schaub
Phone: +49 241 80 21490,
Email: schaub@cs.rwth-aachen.de