Ph.D. Student (f/m/d): Multidimensional Interpolation Algorithms and their Application in Scientific Computing

The Center for Advanced Systems Understanding (CASUS) is a German-Polish research center for data-intensive digital systems research. We combine innovative methods from mathematics, theoretical systems research, simulations, data science, artificial intelligence, and computer science to provide solutions for a range of disciplines – materials science under ambient and extreme conditions, earth system research, systems biology and medicine, and autonomous vehicles.

CASUS was jointly founded in August 2019 by the Helmholtz-Zentrum Dresden-Rossendorf (HZDR), the Helmholtz Centre for Environmental Research (UFZ), the Max Planck Institute of Molecular Cell Biology and Genetics (MPI-CBG), the Technical University of Dresden (TUD) and the University of Wroclaw (UWr). CASUS is located in the heart of Görlitz at the border between Germany and Poland. The CASUS start-up phase is hosted by the Helmholtz-Zentrum Dresden-Rossendorf and is financed by the Federal Ministry of Education and Research (BMBF) and the Saxon State Ministry for Higher Education, Research and the Arts (SMWK).

The CASUS Department of Systems Biology is looking for a PhD Student excited about **novel mathematical approaches to fundamental algorithms in scientific computing**. Consideration of candidates will begin immediately and will continue until the position is filled. Location of work is Görlitz, remuneration is according to the German Civil Service Tariff and HZDR employment conditions. No tuition charged.

The Scope of Your Job

The project is embedded in a larger collaboration with MPI-CBG and TUD's Department of Mathematics and aims to exploit recent advances in algebraic topology to provide novel algorithms for solving high-dimensional interpolation problems with vastly improved computational performance and accuracy. Interpolation is at the heart of many applications in scientific computing, from numerical solutions of differential equations, to deep learning. You will work with experts in the field of mathematics to further develop the algorithmic foundations, and with colleagues from the other CASUS Departments in order to apply the new algorithms. Applications include, but are not limited to, surrogate modeling for machine learning, environmental data science and ecology, and numerical solutions of 6-dimensional models in plasma physics. Another exciting direction includes the formal derivation of high-dimensional cubature formulas, and applications in discretizing active polar gel models for biological tissue dynamics.

Your Tasks

- Derive efficient cubature formulas in high dimensions based on earlier work (https://arxiv.org/abs/1812.04256)
- Apply the results to solve Vlasov-Fokker-Planck equations in 6D phase space
- Derive preconditioning schemes for mesh-free DC-PSE discretization of partial differential equations
- Apply the results to numerical simulations of 3D tissue biomechanics
- Implement the resulting algorithms in the parallel computing framework OpenFPM
- Publish your results in academic, peer-reviewed journals
- Present your results at scientific meetings

Your Qualifications

- Master's degree in Mathematics (applied or pure)
- A solid background in computing and natural science
- Programming skills in languages such as Python or C++
- Experience in Functional Analysis, Approximation Theory, and Algebraic Topology
- Strong motivation to work in a collaborative and interdisciplinary environment
- Excellent communication skills in English and in a professional context (presentation of research results at scientific meetings, colloquial discussions, writing of manuscripts).

What We Offer

- A vibrant research community in an open, diverse, and international work environment
- Scientific excellence and high quality of training according to the Helmholtz Doctoral Guidelines
- Broad national and international science networks
- Cutting-edge, professionally managed high-performance computing resources
- Scientific computing and software engineering support team
- Salary according to the German Collective Wage Agreement for the Civil Service (TVöD)
- Comprehensive benefits package (30 vacation days per year, company pension plan (VBL), flexible working hours, in-house health management, relocation assistance).

Please submit your application (including a one-page cover letter, CV, academic degrees, transcripts, etc.) online on the HZDR application portal:

https://www.hzdr.de/db/Cms?pNid=490&pOid=61504&pContLang=en

Deadline:

Rolling application – open until filled.

For details please contact:

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