— Project 1 —

Computational methods for inference of large sequencing datasets

Main supervisor: Kristoffer Sahlin (ksahlin@math.su.se)
Co-supervisor: Chinmay Dwibedi (Umeå University)

We are seeking a motivated PhD candidate to develop novel algorithms for large-scale sequence analysis. The project focuses on designing efficient methods for processing extremely large and repetitive sequencing datasets, with particular relevance to metagenomic applications. The developed methods will be applied to large human gut microbiome datasets, enabling strain-level analysis at unprecedented scale.

This interdisciplinary project combines algorithm design, high-performance computing, software development, and analysis of both simulated and real biological data. The candidate will work at the interface of bioinformatics, data structures, and microbiome research. While the primary emphasis is methodological and computational, the student is expected to acquire sufficient molecular biology knowledge to engage effectively in the interdisciplinary research environment.

We seek applicants with a strong background in computer science, mathematics, statistics, or bioinformatics, and solid programming skills. Previous experience with biological sequencing data is beneficial but not required.

For questions about the position, contact ksahlin@math.su.se

— Project 2 —

Advanced computational methods for rational approximation: PDEs, industrial applications, and much more

Main supervisor: Davide Pradovera (davide.pradovera@math.su.se)

The research group of Davide Pradovera (https://pradovera.github.io/) at the Department of Mathematics (Division of Computational Mathematics), Stockholm University, is inviting applications for a PhD position in Numerical Analysis and Scientific Computing.

Approximation via rational functions (the ratio of two polynomials) has been a classical topic in numerical analysis for more than a century, dating back to the seminal work of Padé. Despite intrinsic limitations in terms of reliability, fundamentally related to conditioning issues and possible instabilities due to near-singular representations, rational approximation has experienced a remarkable resurgence over the last two decades. This renewed interest is driven by its superior flexibility and approximation power compared to alternative methods, as well as its successful use in several industrial settings. The recent surge of interest has been accompanied by the development of cutting-edge algorithms that address numerical challenges in a pragmatic and computationally efficient manner.

This PhD project aims to develop, analyze, and implement novel numerical methods for rational approximation. A central objective is the practical relevance of the developed techniques, potentially including:
- robustness with respect to noise and ill-conditioning;
- adaptive sampling strategies;
- computational efficiency through advanced linear algebra techniques;
- efficient implementation on modern high-performance computing architectures.

Depending on the candidate's background and interests, applications of rational approximation may include:
- surrogate modeling of partial differential equations (PDEs), with particular emphasis on wave scattering problems;
- system identification and surrogate modeling of discrete dynamical systems, for instance in control applications;
- tasks in computational linear/nonlinear algebra, including matrix approximation/factorization and nonlinear eigenvalue problems.

This project combines mathematical analysis, algorithm design, and high-performance scientific computing. The successful candidate is expected to contribute both theoretically and computationally. As such, we seek candidates with a strong background in Numerical Analysis and Scientific Computing. Experience in programming (e.g., Python, Julia, or C/C++) is required. Experience with HPC environments is beneficial but not mandatory. Feel free to get in contact if you have any question when preparing your application.

Keywords: Numerical analysis, rational approximation, scientific computing, computational linear algebra, surrogate modeling