Bernoullis Tafelrunde

Math Students and PhDs Seminar

Tuesday, 09 December 2025, 12:15-13:00
Seminar Room 05.001, Spiegelgasse 5

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Alternating and parallel tensor-train methods: local convergence and preconditioning ideas for large eigenvalue problems

Abstract

The Density Matrix Renormalization Group algorithm (DMRG) is a popular alternating optimization scheme to solve high-dimensional eigenvalue problems arising in the context of quantum many-body systems. In recent years, the development of several low-rank tensor formats has enabled the design and analysis of new methods capable of approximating, with high accuracy, the solutions of such large-scale problems. One format that has proven particularly successful in tackling tensor-structured linear and eigenvalue problems is the *tensor-train* format, introduced to the numerical analysis community, long after it had been known and used by the quantum physics community under the name of matrix product states. The equivalence between these two notions has allowed for a more rigorous treatment of the DMRG algorithm, which can now be understood as an alternating scheme for addressing general high-dimensional optimization problems.

Although many convergence properties of DMRG remain poorly understood, some satisfactory results have been obtained regarding its local convergence behavior. Thus, in the first part of this talk, I will introduce the main tools involved in analyzing the local convergence properties of DMRG, and extend these tools to obtain an analogous result for a recent parallel version of the algorithm, inspired by two-level additive Schwarz methods.

The search for a parallel version of DMRG is motivated by its inherently sequential nature, which generally hinders efficient implementation on parallel computing architectures and thus limits its overall computational cost. Related developments have recently demonstrated how to efficiently construct algebraic two-level additive Schwarz preconditioners that significantly accelerate iterative linear solvers such as CG. In the second part of this talk, I will give an overview of preconditioning strategies for (symmetric) eigenvalue problems, discuss their impact on the convergence behavior of iterative eigensolvers (e.g. Jacobi–Davidson, LOBPCG), and describe ongoing work aimed at adapting additive Schwarz ideas in this context.

Scan before 08 December at 18:00 to register for lunch