INdAM Workshop
Inverse Problems and Applications

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Optimal finite difference grids for direct and inverse Sturm Liouville problems

Work in collaboration with Vladimir Druskin, Schlumberger Doll

We study finite difference approximations of solutions of direct and inverse Sturm Liouville problems, in a finite or infinite interval on the real line. The discretization is done on optimal grids, with a three-point finite difference stencil. The optimal location of the grid points is calculated via a rational approximation of the Neumann to Dirichlet map and the latter converges exponentially fast. We prove that optimal grids obtained for constant coefficients are asymptotically optimal for variable coefficient direct problems. We also show that optimal grids, together with methods of inverse spectral problems for Jacobi matrices, can be used for the solution of continuous inverse Sturm Liouville problems. In particular, we formulate and analyze a new inversion algorithm, where the unknown coefficients that we image are optimally discretized. We prove that optimal grids provide necessary conditions for convergence of the discrete inverse problem and we demonstrate the effectiveness of our imaging approach through numerical simulations.