Comparison of Analytically and Algebraically Constructed Low Rank Approximations in Kernel-based Scattered Data Interpolation

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Kernel-based scattered data interpolation leads to dense, ill-conditioned systems of equations which are challenging to solve iteratively. Several techniques based on locally separable approximations of the kernel function lead to data-sparse approximations of the interpolation matrix based on low-rank formats.

In this talk, we will review several analytic and algebraic approaches to construct H-matrix approximations to the interpolation matrix. We compare them (numerically) when applied to four different kernel functions used in interpolation problems in one, two or three spatial dimensions. In particular, we analyse the complexity of the construction of the H-approximation and study the effect of solving an approximate interpolation problem on the accuracy of the solution. Given such an H-matrix approximation (computed using a high accuracy), we compute its H-LU factorization (using a lower accuracy) which serves as a preconditioner in an iterative solution. We will provide numerical tests to illustrate the effect of various factors such as the choice of kernel function, the spatial dimension, the shape factor, the accuracy of the H-LU factorization, on the performance of the resulting iterative solver.

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