Robust structured block preconditioning for kernel matrices

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In this talk, we present a robust structured block preconditioning technique for dense kernel matrices. A kernel matrix A is defined by a kernel function κ and a dataset X where each entry of A is equal to the function evaluation of κ at a pair of points. For a given dataset, the spectral property of A can change dramatically as the parameters in κ change. We first propose a reordering technique to decompose A into a block 2-by-2 form based on the geometry of the data points and parameters of the kernel function. We prove that the reordering technique has the rank-revealing property and the condition number of the preconditioned matrix can be bounded when the Schur complement is approximated with a diagonal matrix. We then propose a sparsification technique to sparsify the (1,1) block and hierarchical low-rank approximation technique to approximate the (1,2) and (2,1) blocks in order to reduce the application and storage cost of the proposed preconditioner. Numerical experiments show that the proposed method is robust to kernel matrices with different spectral decay properties and offers competitive performance against other methods on real datasets.

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