ALGEBRAIC MULTILEVEL PRECONDITIONERS ON MASSIVELY PARALLEL COMPUTERS

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Abstract

Algebraic multilevel techniques for defining preconditioners have proven to be very effective when used with Krylov methods. In most cases, they can solve linear systems arising from the discretization of PDEs with a number of floating point operations proportional to the number of unknowns. However, using these multilevel techniques on linear systems arising from the discretization of systems of partial differential equations is not always efficient, particularly on parallel computers. Domain decomposition techniques have to be used to parallelize the smoothers and the coarsening algorithms.

Moreover, the algebraic multilevel preconditioners involve operations like interpolation which is done by using the matrix entries and, in some problems, it does not make too much sense to interpolate some unknowns of the system with entries corresponding to unknowns of a different type arising from another equation in the PDE system.

In this paper, we shall provide some numerical results on parallel computers with a large number of processors. We shall also propose to use the natural block structure of the matrix to define block multilevel preconditioners to solve problems arising from systems of PDEs. The size of the blocks generally corresponds to the number of equations in the PDE system. Of course, we have to be careful when defining the smoother, the interpolation and the way by which the coarse levels are defined. We shall illustrate this by exemples modelling systems of PDEs arising from three–temperature diffusion approximations of the transport equation in radiative transfer problems.