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A Supernodal Approach to ILU with Partial Pivoting

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We present a new supernode-based incomplete LU factorization method to construct a preconditioner for solving sparse nonsymmetric linear systems with iterative methods. The new algorithm is primarily based on the ILUTP approach by Saad, and we incorporate a number of techniques to improve the robustness and performance of the traditional ILUTP method. We present numerical experiments to demonstrate that our new method is competitive with the other ILU approaches and is well suited for today's high performance architectures.

Our contributions can be summarized as follows. We adapt the classic dropping strategies of ILUTP in order to incorporate supernode structures and to accommodate dynamic supernodes due to partial pivoting. For the secondary dropping strategy, we propos an area-based fill control method, which is more flexible and numerically robust than the traditional column-based scheme. Furthermore, we incorporate several heuristics for adaptively modifying various threshold parameters as the factorization proceeds, which improves the robustness of the algorithm. Finally, the implementation of the algorithm has already been incorporated in the SuperLU Version 4.0 release, downloadable at http://crd.lbl.gov/~xiaoye/SuperLU/.