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On absolute value equations associated with M-matrices

We consider the absolute value equation (AVE) $Ax - |x| = b$, where A is an $n \times n$ matrix such that $A - I$ is a nonsingular M-matrix or an irreducible singular M-matrix. We show that the generalized Newton method (GNM) terminates with the exact unique solution in at most $n + 2$ iterations when $A - I$ is a nonsingular M-matrix and in at most $n + 1$ iterations when $A - I$ is an irreducible singular M-matrix and the AVE has a unique solution. When $A - I$ is an irreducible singular M-matrix, the AVE may have infinitely many solutions. In this case, we show that GNM always terminates (in at most $n + 1$ iterations) with a uniquely identifiable solution, as long as the initial guess has at least one nonpositive component. The GNM requires $O(n^3)$ operations each iteration. Linear convergence of a generalized Gauss-Seidel iteration (GGS), which requires $O(n^2)$ operations each iteration, is known when $A - I$ is a nonsingular M-matrix. We show that GGS is still linearly convergent when $A - I$ is an irreducible singular M-matrix and the AVE has a unique solution.