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LSMR: An iterative algorithm for least-squares problems

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An iterative method is presented for solving linear systems $Ax = b$ and $\min \|Ax - b\|_2$, with A being large and sparse, or a fast linear operator. The method is based on the Golub-Kahan bidiagonalization process. It is analytically equivalent to the standard method of MINRES applied to the normal equation $A^T Ax = A^T b$, so that the quantities $\|A^T r_k\|$ are monotonically decreasing (where $r_k = b - Ax_k$ is the residual for the current iterate x_k). In practice we observe that $\|r_k\|$ also decreases monotonically. Compared to LSQR, for which only $\|r_k\|$ is monotonic, it is safer to terminate LSMR early.