

8.5 MATLAB sparse backslash

Almost the entire book (and more) is encapsulated in the single MATLAB statement $x=A\b$. The single character “\” invokes a host of powerful matrix solvers (LAPACK, the BLAS, UMFPACK, CHOLMOD, GPLU, Givens-based sparse QR factorization, Maple, and many specialized solvers). The algorithm follows the following steps in order. It uses the first method that fits the given rule and succeeds. If the linear system is not too ill-conditioned (and even sometimes when it is), backslash (`mldivide` as it is formally known) nearly always finds a good solution.

1. If A is a symbolic matrix, the Symbolic Toolbox (Maple) solves it symbolically.
2. If A is sparse and diagonal, b is scaled. See `cs_scale` in Problem 2.4.
3. If A is sparse, square, and banded (with a sufficiently dense band), either a tridiagonal solver or a band solver (in LAPACK) is used.
4. If A is a lower or upper triangular sparse matrix, a forward solve or backsolve is used (like `cs_lsolve` and `cs_usolve`). If it is a full matrix, the BLAS triangular solvers are used.
5. If A is a permuted triangular matrix, a permuted backsolve is used (one solver for the sparse case and another for the full case). See Problem 3.7.