SCA/LAPACK

One of the main strengths of Sca/LAPACK is the widespread support and recognition from the international dense linear algebra community. Researchers, vendors, and individuals all over the world are regularly contributing to the Sca/LAPACK software library.

The University of Tennessee's Innovative Computing Laboratory (ICL), the University of Colorado Denver, and the University of California, Berkeley are responsible for the development, integration, and verification of those contributions.

Current activity consists of including new functionalities that enrich LAPACK's already impressive capabilities, adding new algorithms that provide faster and more accurate results, maintaining our libraries to guarantee their reliability, providing user support, and increasing ease of use.

LAPACK 3.9.0 *Coming NOVEMBER 2018*

NEW FUNCTIONALITIES

A QR-preconditioned QR SVD method for computing the SVD with high accuracy

CONTRIBUTION BY

Zlatko Drmac
University of Zagreb

LAPACK Householder Reconstruction

CONTRIBUTION BY

Igor Kozachenko
UC Berkeley

Jim Demmel
UC Berkeley

BLAS++ and LAPACK++ C++ binding libraries (link only)

CONTRIBUTION BY

Mark Gates
University of Tennessee

CMAKE improvement
Streamlines the configuration of user projects building against LAPACK or LAPACKE

CONTRIBUTION BY

Jean-Christophe Fillon-Robin
Kitware inc.

FIND OUT MORE AT www.netlib.org/lapack/improvement.html

DID YOU KNOW?

- EISPACK and LINPACK (ancestors of LAPACK) were two of the first libraries made publicly available.
- In 1979, the LINPACK benchmark was initially written for timing references. It has since become the popular benchmark that is used to rank the TOP500 computer list. A highly efficient implementation of the benchmark is HPL from UTK, which is a tuned version of PDGESV from ScaLAPACK.
- LAPACK can solve the symmetric eigenvalue problem in five different ways. One can either use QR (STEQR), QR only eigenvalues (STERF), Bisection and Inverse Iteration (STEBZ+STEIN), Divide and Conquer (STEDC), or MRRR (STEGR). Each of these methods has its own importance, and the LAPACK drivers enable users to pick the appropriate one according to the problem at hand.
- LAPACK is written in Fortran and has a native C interface.
- LAPACK can run up to 100 times slower if it is not calling an optimized BLAS library.
- Matlab uses its own LAPACK library behind the scene. The performance of your Matlab is thus closely related to the performance of LAPACK.
- BLACS enables users to send messages from one process to the others. The BLACS communication standard interface and the initial BLACS library were written for that purpose, before the MPI standard, and before any MPI library ever existed.
- The BLAS/LAPACK/BLACS/ScaLAPACK test and timing suites provide a convenient and exhaustive way of testing and timing a third party library.
- LAPACK and ScaLAPACK have been available for Windows since 2006.
- A great forum is available for support and discussions at http://icl.eecs.utk.edu/lapack-forum/.

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http://www.netlib.org/**scalapack**

SCA/LAPACK

LAPACK is an open-source library for solving dense numerical linear algebra problems. It is designed to run efficiently on modern processors by making extensive use of Level-3 BLAS. **ScaLAPACK provides most of the functionalities of LAPACK but for distributed memory parallel systems.** The goals of the Sca/LAPACK projects are to provide efficiency, portability, scalability, flexibility, reliability, ease of maintenance, and ease of use software for computational science problems.

FUNCTIONALITIES

LAPACK provides routines for solving:

- Linear Equations (SV) for nonsymmetric, symmetric, and symmetric positive definite matrices using LU, LDLT, and Cholesky factorizations, respectively.
- Linear Least Squares (LLS)
- Generalized Linear Least Squares (LSE and GLM)
- Standard Eigenvalue and Singular Value Problems
  - Symmetric Eigenproblems (SEP)
  - Nonsymmetric Eigenproblems (NEP)
  - Singular Value Decomposition (SVD)
- Generalized Eigenvalue and Singular Value Problems
  - Generalized Symmetric Definite Eigenproblems (GSEP)
  - Generalized Nonsymmetric Eigenproblems (GNEP)
  - Generalized Singular Value Decomposition (GSVD)

Input matrix layout can be dense, banded, tridiagonal, bidiagonal, or packed (for symmetric or triangular matrices).

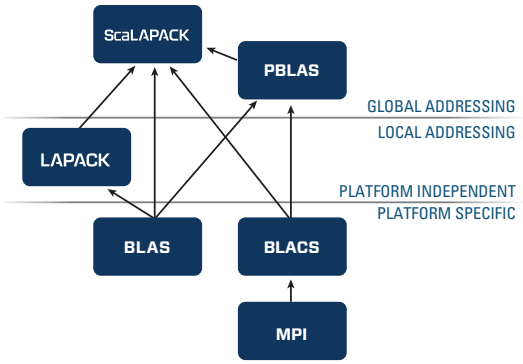
For each driver, an expert version is provided, and subroutines are defined in 4 ways: real (s), complex (c), double precision (d), and double complex (z).

DISTRIBUTION

The Sca/LAPACK source code is distributed through http://www.netlib.org/ under modified BSD license. The libraries are regularly tested on numerous machines using multiple computers. The Sca/LAPACK APIs have been adopted by many vendors, and the Sca/LAPACK public version provides a reference implementation of state-of-the-art algorithms for a wide set of problems. LAPACK has been incorporated into the following commercial packages (often with some shared memory LAPACK implementations and the parallel distributed version of ScaLAPACK): AMD, Apple, Compaq, Fujitsu, Hewlett-Packard, Hitachi, IBM, Intel, MathWorks, NAG, NEC, PGI, Oracle, Rogue Wave. It is also distributed in most Linux distributions (e.g., Fedora, Debian, and Cygwin).

ARCHITECTURE DESIGN

LAPACK makes extensive use of BLAS calls. This enables LAPACK to maintain its efficiency when ported from one platform to another. ScaLAPACK software is multi-layered, enabling it to be portable and efficient. Matrices are in the 2-D, block-cyclic format, an important parameter for scalability and efficiency.



USERS

Sca/LAPACK is used by most computational simulation codes to provide efficient, easy to use, and reliable numerical dense linear algebra methods. Many users do not realize that they are using Sca/LAPACK since LAPACK is embedded beneath environments like Matlab, Numeric Python, or R. Sca/LAPACK is used for a number of applications in science and engineering in areas such as quantum chemistry and physics, electromechanics, geophysics and seismology, plasma physics, nonlinear mechanics, chemically reactive flows, helicopter flight control, atomic structure calculation, cardio-magnetism, radar cross-sections, and 2-D elastodynamics. The package is used on dense matrices ranging in size from 2 to 50,000 for LAPACK, and ScaLAPACK is now successfully used on thousands of processors.

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