Chapel + LAPACK:
Linear Algebra Work-Horse Meets High-Performance Jockey

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Problem

The use of a particular language is largely driven by the ecosystem of libraries that it can readily utilize.

LAPACK is a very popular, mature, and performant linear algebra library written Fortran that potential users have noted would allow them to start using Chapel to develop their scientific applications.

LAPACK contains 1946 routines, and its C interface (LAPACKE) contains 3122 routines, making it too difficult to manually port to Chapel.

Further, the Fortran and C code lack much of the syntactic information required to make semantic inferences, and full semantic analysis is difficult.

An automated, heuristic based solution is required for timely deployment.

Solution: Documentation Mining

LAPACK is well documented, and in a way that makes extraction through regular expressions possible.

By mining the documentation, even in this brutish manner, we can glean a wealth of semantic information that would be nearly impossible to get from analyzing the code itself.
- Allows us to determine types and intents for arguments required for generating external procedure declarations.
- Gives context to arguments that could be encapsulated by a single Chapel array argument, and creating idiomatic Chapel procedures.
- Reuse its documentation for chpldocs.

Result: ChaLAPACK
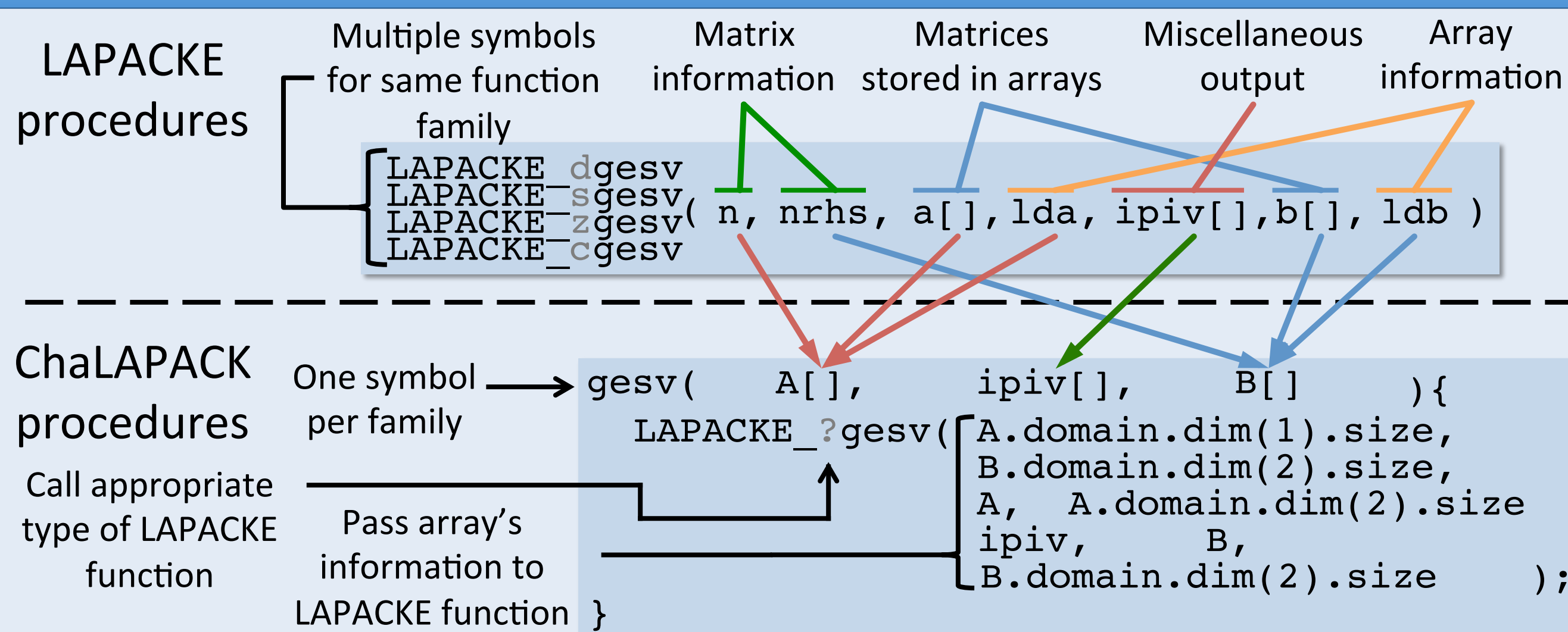
Automatically generated with minimal human input.

Provides:
- Fortran hooks (LAPACK).
- C interface hooks (LAPACKE).
- Chapel array conceptualized procedures (ChaLAPACK).

Future Work

- Column-major order option for arrays in Chapel
  - LAPACKE must convert to CMO because of Fortran.

- Comprehensive testing.
  - The Fortran tests are quite advanced, and could not be immediately converted into Chapel code.

- General C Interface + Documentation → Chapel interface generation framework.
  - No more sketchy hand-carved magic bullets.

- More mathematics/scientific library interfaces.
  - BLAS (Basic Linear Algebra Subroutines)
  - GSL (GNU Scientific Library)