Title: Design by Transformation - Application to Dense Linear Algebra Libraries

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The FLAME project has yielded modern alternatives to LAPACK and related effort. An attractive feature of this work is the complete vertical integration of the entire software stack, starting with low level kernels that support the BLAS and finishing with a new distributed memory library, Elemental. In between are layers that target a single core, multicore, and multiGPU architectures. What this now enables is a new approach where libraries are viewed not as instantiations in code but instead as a repository of algorithms, knowledge about those algorithm, and knowledge about target architectures. Representations in code are then mechanically generated by a tool that performs optimizations for a given architecture by applying high-level transformations much like a human expert would. We discuss how this has been used to mechanically generate tens of thousands of different distributed memory implementations given a single sequential algorithm. By attaching cost functions to the component operations, a highly optimized implementation is chosen by the tool. The chosen optimization invariably matches or exceeds the performance of implementations by human experts. We call the underlying approach Design by Transformation (DxT).

Biography:

Robert van de Geijn is a Professor of Computer Science and member of the Institute for Computating Engineering and Sciences at UT-Austin. He received his Ph.D. in Applied Mathematics from the University of Maryland. His interests are in linear algebra libraries, scientific computing, parallel computing, and formal derivation of programs. His FLAME project pursues how fundamental techniques from computer science support high-performance linear algebra libraries. He has written more than a hundred refereed articles and several books on this subject.

This work is in collaboration with Bryan Marker, Don Batory, Jack Poulson, and Andy Terrell.