Using Recursion to Improve Performance of Dense Linear Algebra Software

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Matrix computations are both fundamental and ubiquitous in computational science and its vast application areas. Along with the development of more advanced computer systems with complex memory hierarchies, there is a continuing demand for new algorithms and library software that efficiently utilize and adapt to new architecture features. This talk reviews and details some of the recent advances made by applying the paradigm of recursion to dense matrix computations on today's memory tiered computer systems.

Recursion allows for efficient utilization of a memory hierarchy and generalizes existing fixed blocking by introducing automatic variable blocking that has the potential of matching every level of a deep memory hierarchy. Novel recursive blocked algorithms offer new ways to compute factorizations such as Cholesky and QR and to solve matrix equations. Often a single recursive algorithm can replace both the level 2 and the level 3 algorithm typically used in a fixed blocking algorithm. This leads to both improved performance and reduced software complexity. In fact, the whole gamut of existing dense linear algebra factorization is beginning to be re-examined in view of the recursive paradigm. Use of recursion has led to using new hybrid data structures and optimized superscalar kernels.

The results we survey include new algorithms and library software implementations for level 3 kernels, matrix factorizations, the solution of general systems of linear equations and several common matrix equations. The software implementations we survey are robust and show impressive performance on today's high performance computing systems.

The talk presents joint work with Fred Gustavson, Bo Kågström, and Isak Jonsson. For a general introduction and an extensive list of references, see [1].

References

[1] E. Elmroth, F. Gustavson, I. Jonsson, and B. Kågström. Recursive Blocked Algorithms and Hybrid Data Structures for Dense Matrix Library Software. *SIAM Review*, 46(1): 3–45, 2004.