THE UNIVERSITY OF CHICAGO

Departments of Computer Science, Mathematics, Statistics and the Computation Institute

SCIENTIFIC AND STATISTICAL COMPUTING SEMINAR

EDGAR SOLOMONIK

Department of Computer Science

University of Illinois at Urbana-Champaign

Strassen-like Algorithms for Symmetric Tensor Contractions

THURSDAY, April 13, 2017 at 4:30 PM

226 Jones Laboratory, 5747 S. Ellis Avenue

Host: Lek-Heng Lim

ABSTRACT

In matrix-vector multiplication, matrix symmetry does not permit a trivial savings in computational cost. More generally, in contractions of symmetric tensors, the reduced representations of the tensors often do not yield a savings in computational cost. We introduce an algorithm that uses an algebraic reorganization to reduce the number of elementwise products necessary for these operations, while increasing the number of additions. The algorithm computes some redundant products to preserve symmetry. For multiplication of a symmetric-matrix and a vector, the algorithm reduces the number of necessary products by 2, while for tensors, the reduction grows proportionally to the factorial of the number of tensor modes. Unlike matrix-matrix multiplication, contractions of symmetric tensors are not easily nestible. However, contractions of partially-symmetric tensors can be nested over different symmetric groups of modes, allowing the new algorithm to reduce computational cost. Such partially-symmetric tensor contractions are prevalent in quantum chemistry calculations. Multiplication of a structured (Toeplitz or Hankel) matrix and a vector is a special case of this type of tensor contraction.

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