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Efficient Computation of Higher Order Moment Tensor

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Efficient Computation of Higher Order Moment Tensor

Intern: Zitong Li, Wake Forest University, **Virtual at:** Winston Salem, NC
Mentor: Hemanth Kolla, 8753 Department of Scalable Modeling & Analysis

Abstract The tensor decomposition of the cumulant tensor of time series data can be used to effectively detect and analyze anomalies. However, computing the cumulant tensor can be very expensive. One of the most expensive steps is to compute the moment Tensor. The current state-of-art algorithm takes advantage of the symmetric nature of the moment tensor by dividing it into smaller cubic tensor blocks and only compute the blocks with unique values and thus reducing computation. We designed a new algorithm that poses the computation of the moment tensor in terms of matrix operations (Khatri-Rao product and matrix multiplication). Because this approach is much more cache efficient, we were able to achieve a 5x speedup over the state-of-art with typical input data dimensions on a single processor. Ongoing efforts include implementing this algorithm with Kokkos to make it scalable.

Problem Domain	**Technical Approach**	**Mission Application**
Moment Tensor Computation	Khatri-Rao product	Combustion

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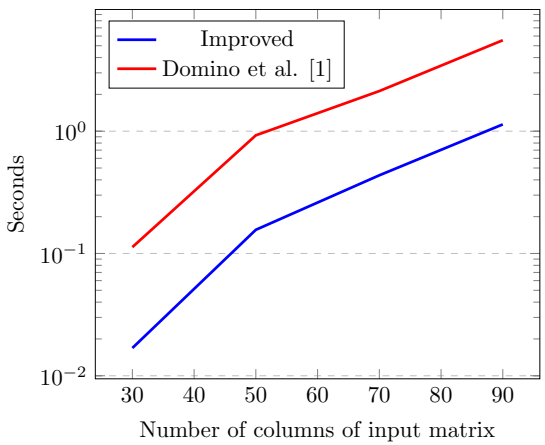
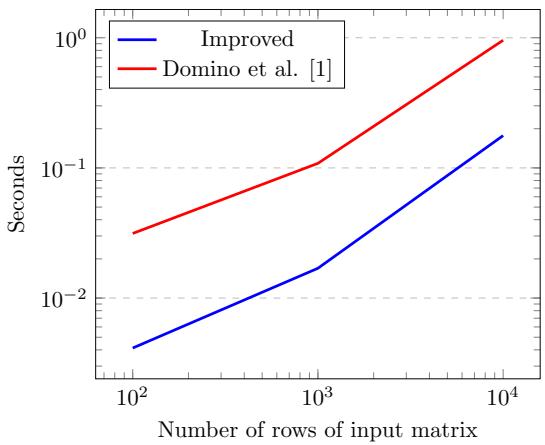
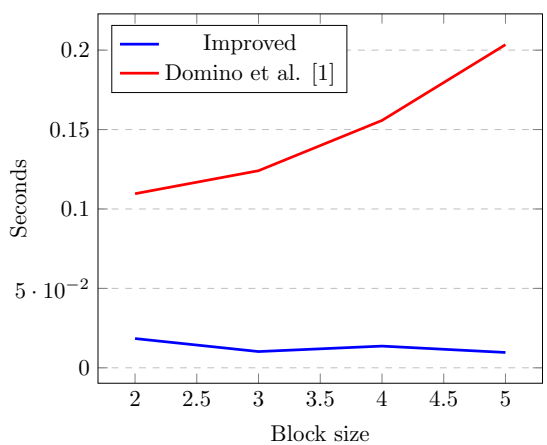
The following experiment is run with synthetic random matrices (1000x30 with a block size of 2). Controlling other parameters, we varied the number of columns and rows of the input matrix and the block size. Our performance is in blue while the red lines represent that of the existing approach by Domino et al.[1].

As we can see, the speedup is consistent around 5x across the different number of columns and rows. The block size also has an impact on the performance. Our approach prefers a larger block size, which results in less saving in terms of memory. However, we are outperforming the existing approach even with smaller block sizes.







[1] K. Domino, P. Gawron, and Ł. Pawela, "Efficient Computation of Higher-Order Cumulant Tensors," SIAM J. Sci. Comput., vol. 40, no. 3, pp. A1590–A1610, Jan. 2018, doi: 10.1137/17M1149365.

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