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Algorithmic and HPC Challenges in Parallel Tensor Computations

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Abstract

Tensors, or multi-dimensional arrays, have been increasingly used in the recent past in many application domains including signal processing, quantum chemistry, data analysis and machine learning. Tensor decompositions, generalization of matrix decompositions such as SVD to higher dimensions, are employed to find a low-rank representation of data in these applications.

This in turn enables finding feasible solutions to the problem at hand with a proper interpretation of this compact representation. Specifically, sparse tensor decompositions are used in data analysis involving recommender systems, graph analytics, and anomaly detection in order to predict missing entries in the tensor, while dense tensor decompositions are heavily employed in signal processing for the detection of unknown signal sources. Recently, another promising use case of tensors have arised in the

solution of linear systems and eigenvalue problems in higher dimensional problems where matrices and vectors can be expressed using low-rank tensor decompositions, and all matrix-vector operations can be carried out in this compressed form with tremendous computational and memory gains. In all these applications, computing tensor decompositions efficiently is indispensible for rendering tensor methods practical when dealing with data of massive scale. The focus of this talk is challenges encountered in accelerating the computation of tensor decompositions using effective shared/distributed memory parallelization, partitioning strategies, data structures, and algorithms.

Short bio

Oguz Kaya is a post-doctoral researcher in the HiePACS team at INRIA Bordeaux working on the parallel tensor decomposition algorithms. He obtained his PhD. from École Normale Superiéure de Lyon in September 2017 under the supervision of Prof. Yves Robert and Dr. Bora Uçar. He is the recipient of multiple awards including two-times winner of the HPC Hackathon organized at Barcelona Supercomputing Center, SIAM Student Travel Award, CORDI-FRM scholarship during his doctoral studies, and bronze medal in International Olympiads in Informatics (IOI). His research focuses on combinatorial and HPC challenges in (multi)linear algebra kernels, including devising effective parallelization, load balancing and communication strategies as well as data structures and algorithms towards achieving high performance on modern architectures.