Internship subject: *Tensor computations on GPUs*
Advisor: Suraj Kumar
Location: ROMA team, Inria & ENS Lyon, France

Context

Tensors are multi-dimensional arrays and used to store data in several domains [3], such as data mining, neuroscience and computer vision. Tensor decompositions help to identify inherent structure of data, achieve data compression and enable various ways of data analysis. CP (also known as Canonical Polyadic or CANDECOMP or PARAFAC) is one of the widely used tensor decompositions in the literature for data analytics [2].

Computing a CP decomposition involves solving a nonlinear optimization problem to minimize the approximation error. The workhorse algorithm to compute this decomposition uses an alternating least squares approach. This works in multiple iterations. For a d-dimensional decomposition, in each iteration, d matricized-tensor times Khatri-Rao product (MTTKRP) computations are performed. In this computation, a matrix representation of the original tensor is multiplied with the Khatri-Rao product of $d-1$ factor matrices. This is the bottleneck computation of the algorithm [1]. We will design efficient parallel GPU algorithms for MTTKRP by taking hardware details into account.

Main Activities

We will perform the following activities:

- Design efficient parallel GPU algorithms for 3-dimensional MTTKRP computations
- Implement the proposed algorithms on modern GPUs

Skills

Familiarity with Linear Algebra and GPU computations will be much appreciated.

Salary and duration

Payment: ∼600 euros per month
Duration: 5-6 months
Contact: Suraj Kumar (suraj.kumar@inria.fr)

References

[1] Grey Ballard, Nicholas Knight, and Kathryn Rouse. Communication lower bounds for matricized tensor times khatri-rao product. In *2018 IEEE International Parallel and Distributed Processing Symposium (IPDPS)*, pages 557–567, 2018.

[2] David Hong, Tamara G. Kolda, and Jed A. Duersch. Generalized canonical polyadic tensor decomposition. *SIAM Review*, 62(1):133–163, 2020.

[3] Tamara G. Kolda and Brett W. Bader. Tensor decompositions and applications. *SIAM Review*, 51(3):455–500, 2009.