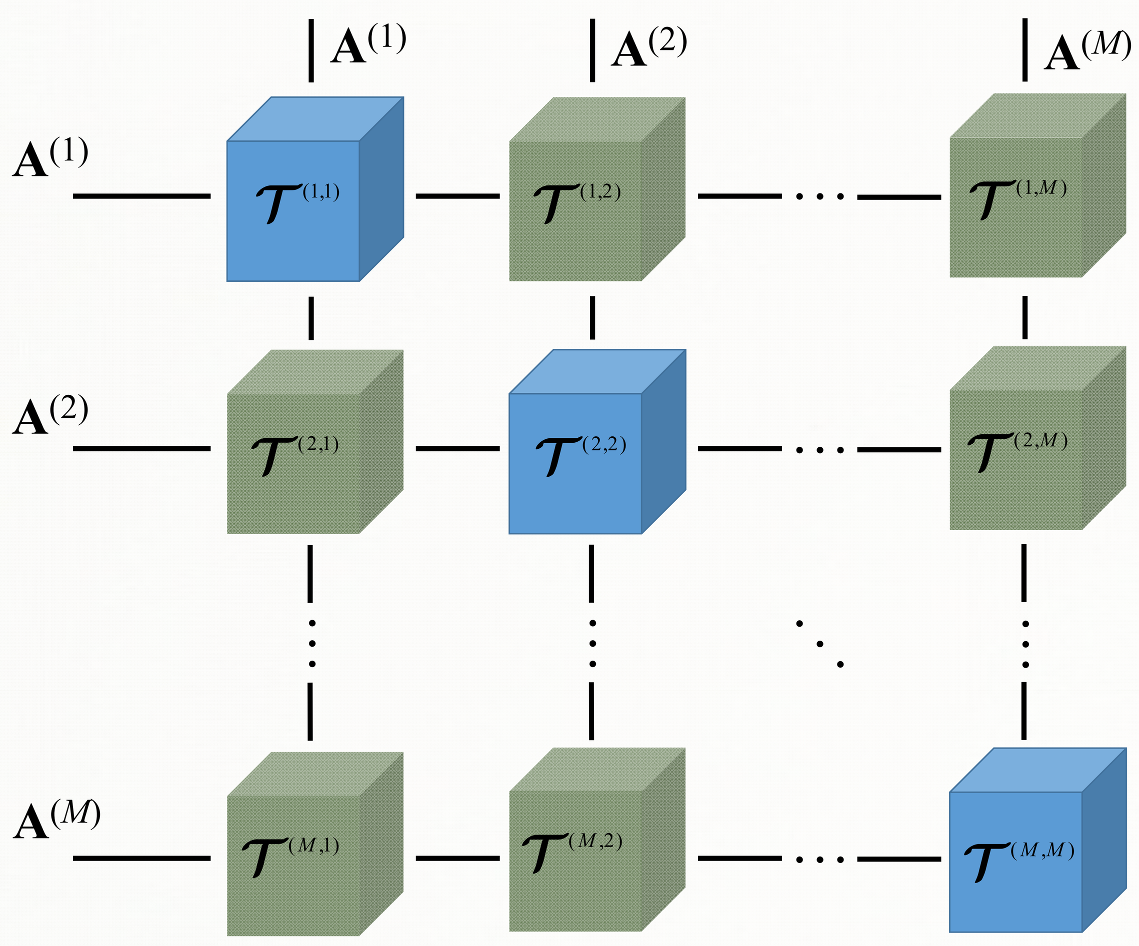
Coupled Rank-(L_m, L_n, ·) Block Term Decomposition

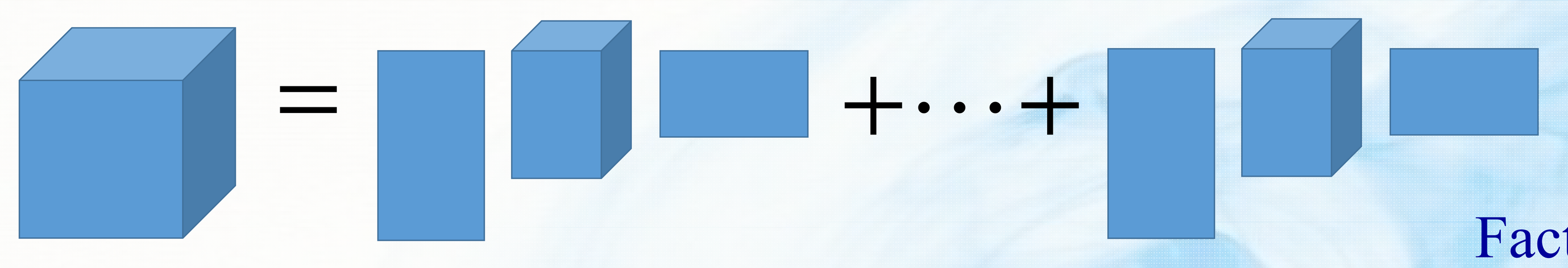
Xiao-Feng Gong, Qiu-Hua Lin, Otto Debals, Nico Vervliet, Lieven De Lathauwer

E-mail: xfgong@dlut.edu.cn

WHAT?



- **Each tensor $\mathcal{T}^{(m,n)}$ has a rank-(L_m, L_n, ·) BTD formulation**



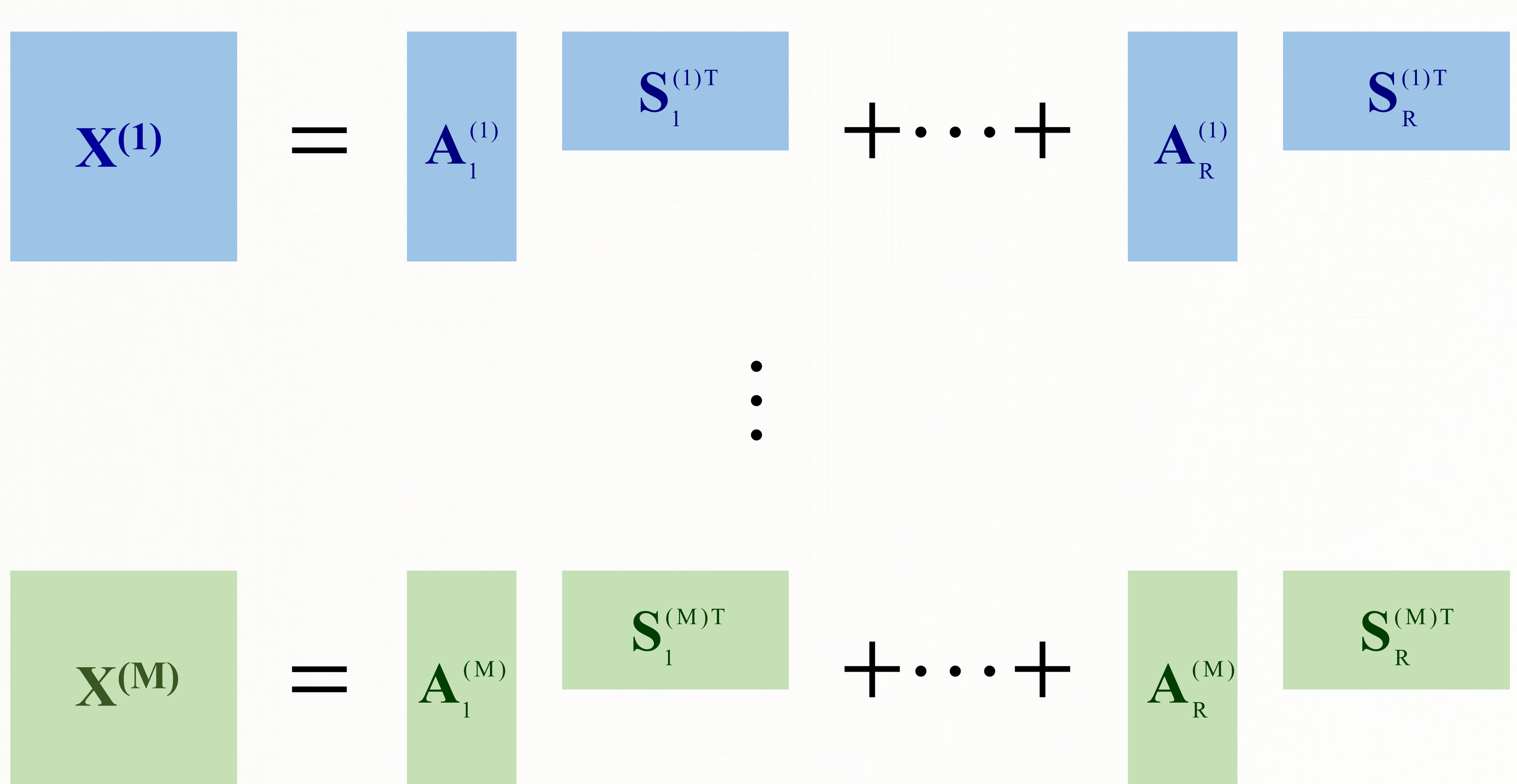
$$\mathcal{T}^{(m,n)} = \sum_r \mathcal{C}_r^{(m,n)} \times_1 \mathbf{A}_r^{(m)} \times_2 \mathbf{A}_r^{(n)}$$

Factor matrix: $\mathbf{A}^{(m)} = [\mathbf{A}_1^{(m)}, \ldots, \mathbf{A}_R^{(m)}]$

- **Double coupling structure:**

- Tensors $\mathcal{T}^{(m,1)}$, $\mathcal{T}^{(m,2)}$, …, $\mathcal{T}^{(m,M)}$ have common factor matrix $\mathbf{A}^{(m)}$ in the first mode;
- Tensors $\mathcal{T}^{(1,n)}$, $\mathcal{T}^{(1,n)}$, …, $\mathcal{T}^{(M,n)}$ have common factor matrix $\mathbf{A}^{(n)}$ in the second mode.

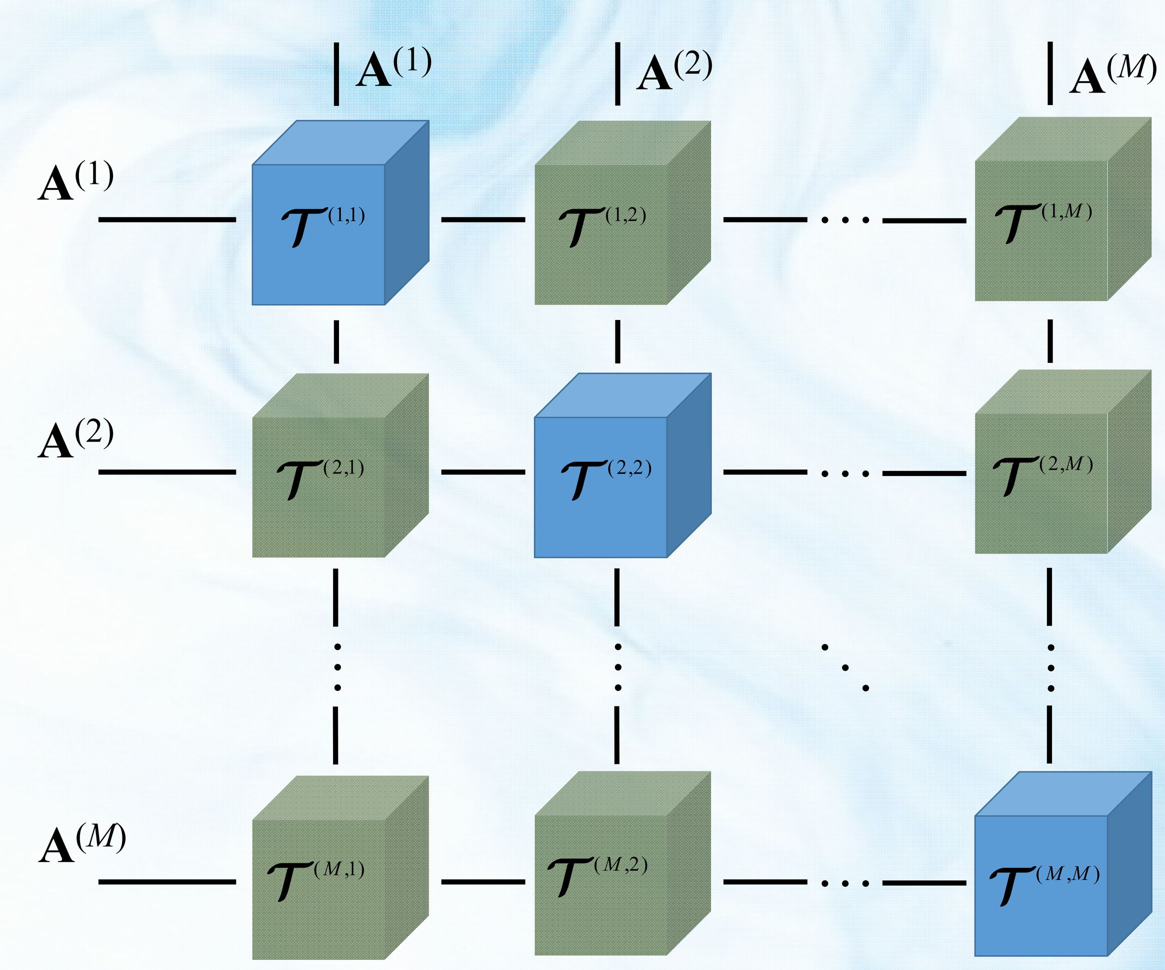
WHY?



Multi-set convolutive mixture

Pairwise covariance

$$\mathcal{T}^{(m,n)}_{(:,:,t)} = \mathrm{cov}\left\{\mathbf{X}^{(m)}_{(:,t)}, \mathbf{X}^{(n)\mathrm{T}}_{(:,t)}\right\}$$



Coupled rank-(L_m, L_n, ·) BTD

Via pairwise cross covariance between each pair of datasets we convert a joint independent subspace analysis (J-ISA) problem to a coupled rank-(L_m, L_n, ·) BTD problem.

HOW?

- **Coupled Block Simultaneous Generalized Schur Decomposition (CB-SGSD):**

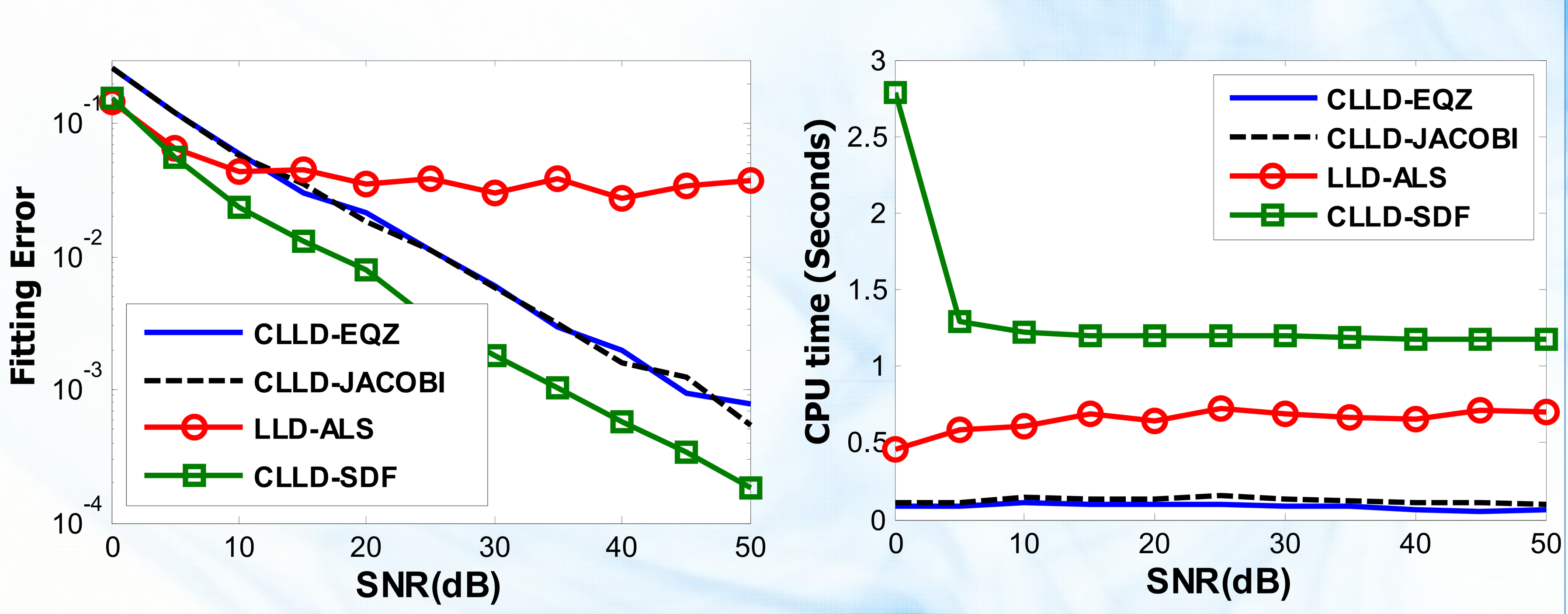
- Extension of existing works on SGSD [A.-J. van der Veen, etc. 1996, L. De Lathauwer, etc. 2004, A. Stegeman, 2009] to the block and coupled case.
- We proposed two algorithms for its computation: (1) extended QZ iteration; (2) Jacobi.

- **Structured data fusion (SDF):**

- The coupled rank-(L_m, L_n, ·) BTD can be implemented via SDF (www.tensorlab.net).

- **Proposed vs. SDF:**

- SDF is more accurate but sensitive to initialization. Proposed algorithms are faster, and thus can be used to provide low-cost initialization for SDF.



Proposed (CLLD-EQZ, CLLD-JACOBI) vs. SDF implementation (CLLD-SDF) and single tensor based uncoupled ALS algorithm (LLD-ALS).