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

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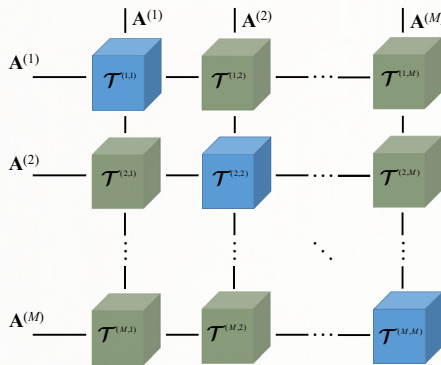
WHAT?

- **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 matrx: $\mathbf{A}_r^{(m)} = [\mathbf{A}_1^{(m)},...,\mathbf{A}_R^{(m)}]$

- **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

$$\mathcal{T}_{(:,:,t)}^{(m,n)} = \mathrm{cov}\left\{ \mathbf{X}_{(:,t)}^{(m)}, \mathbf{X}_{(:,t)}^{(n)\mathrm{T}} \right\}$$
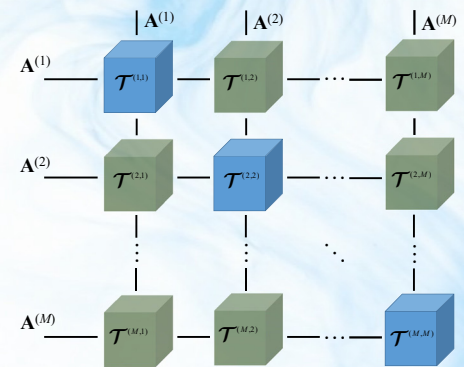
Coupled rank-(L_m, L_n, ·) BTD

Via pairwise cross covariance between each pair of datasets we convert a joint independent subspace analysis (J-ISA) problem to the 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) via 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.
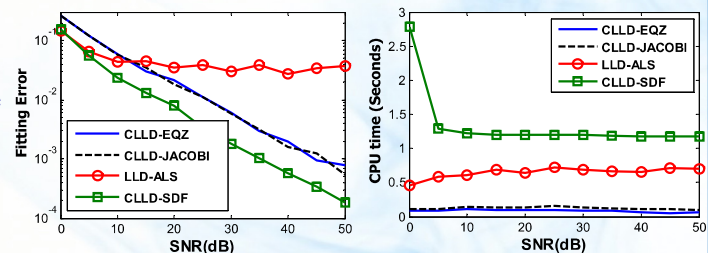
Proposed (CLLD-EQZ, CLLD-JACOBI) vs. SDF implementation (CLLD-SDF) and single tensor based uncoupled ALS algorithm (LLD-ALS).