

## Background and Objectives

### Background

- ▶ Data is often of high-dimension, structured, and incomplete
- ▶ Deep NN model often contains large-scale parameters
- ▶ Tensor network is a promising technology for model compression and efficient computation, but lack of theory and algorithms

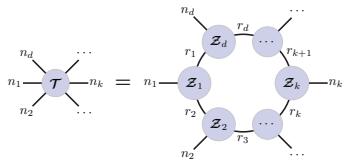
### Objectives

- ▶ Study the fundamental **theory and algorithms** of tensor network
- ▶ To **advance machine learning** methods by leveraging tensor network representations

## Tensor Networks for Data Completion

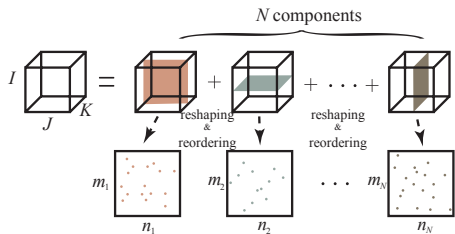
### Tensor network model, theory and algorithm

- ▶ **Tensor ring decomposition** for high-order tensors with highly expressive power and efficient computation [ICASSP'19]



Tensor ring decomposition

- ▶ **Reshuffled tensor decomposition** for exact recovery of latent components with theoretical guarantee [AAAI'20]

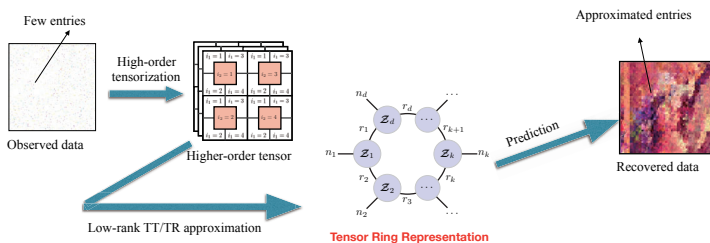


Reshuffled tensor decomposition

$$\min_{\mathbf{A}_i, i \in [N]} \sum_{i=1}^N \|\mathbf{A}_i\|_*, \quad s.t., \mathcal{X} = \sum_{i=1}^N R_i(\mathbf{A}_i),$$

### Tensor completion via tensor network representations

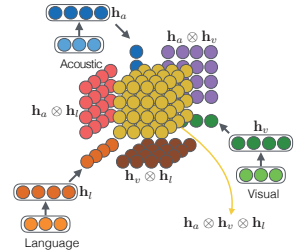
- ▶ Improve **generalization ability** of tensor completion by imposing low-rankness regularizer on tensor ring latent cores [AAAI'19]
- ▶ Scalable and fast randomized tensor ring decomposition algorithm [ICASSP'19, best student paper]
- ▶ Tensor ring with **latent nuclear norm** regularization [ACML'19]
- ▶ Application to **hyper-spectral image** restoration [CVPR'19 Oral]
- ▶ **Theoretical analysis** on consistency of tensor completion under the multiple linear transformations [CVPR'19, Oral]



## Multimodal Learning via Tensor Networks

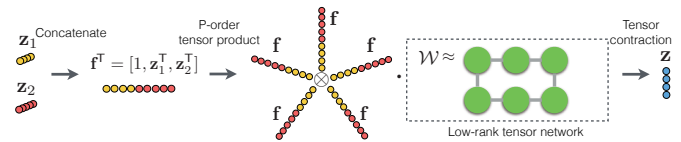
### Motivation

- ▶ Multimodal fusion is a key step of multimodal recognition.
- ▶ Tensor fusion has achieved a great success.
- ▶ High-order statistical information is ignored.

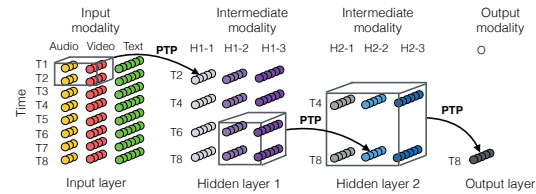
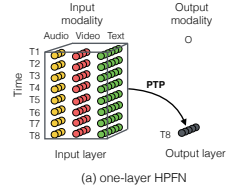


### Deep multimodal learning with high-order polynomial tensor fusion [NeurIPS'19]

- ▶ Polynomial tensor pooling (PTP)
- ▶ Reduce computation complexity by low-rank **tensor networks**

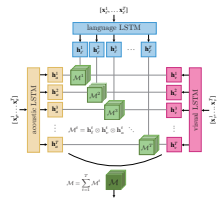


- ▶ **Single-layer** polynomial fusion network
- ▶ **Multi-layer** hierarchical polynomial fusion network
- ▶ PTP treated as a **"fusion filter"** analogous to a CNN filter



### Learning representations from imperfect time series data via tensor rank regularization [ACL'19]

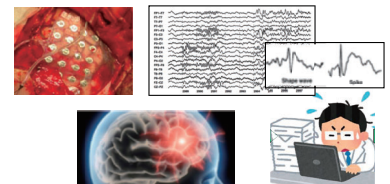
$$\|\mathcal{X}\|_* = \inf \left\{ \sum_{i=1}^r |\lambda_i| : \mathcal{X} = \sum_{i=1}^r \lambda_i \left( \bigotimes_{m=1}^M \mathbf{w}_m^i \right), \|\mathbf{w}_m^i\| = 1, r \in \mathbb{N} \right\}$$



## AI Support for Epileptic Diagnosis

### Challenging problems

- ▶ Limited number of eligible doctors in Japan
- ▶ Diagnosis procedure is time consuming



### Goal

- ▶ Automatic **localization** of epileptic focal from iEEG signals as a support technology for doctors
- ▶ High detection accuracy
- ▶ Less ground-truth labels
- ▶ Subject unspecific system

