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Data with Multimodality

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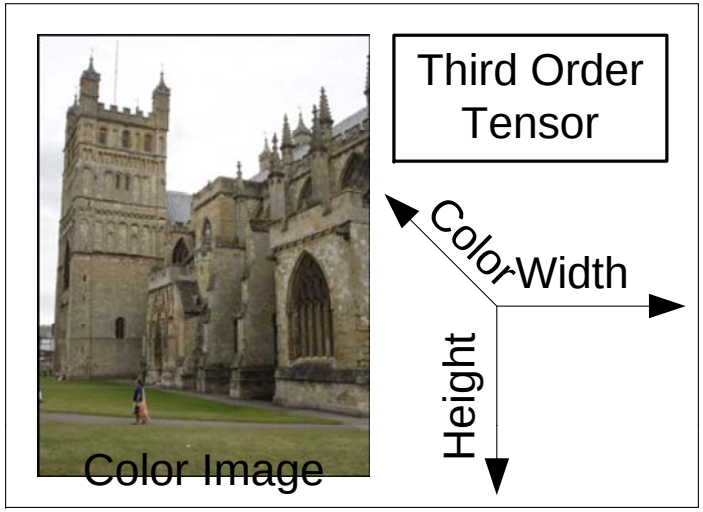
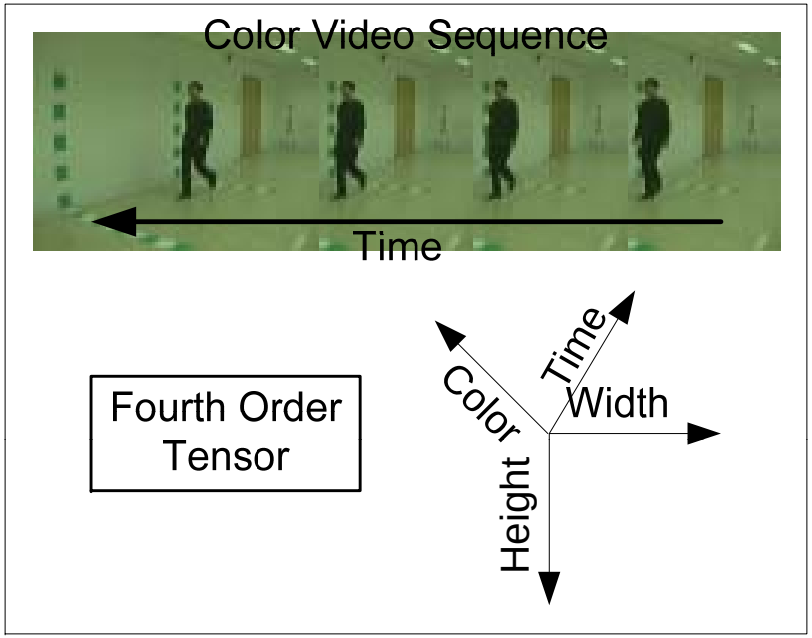
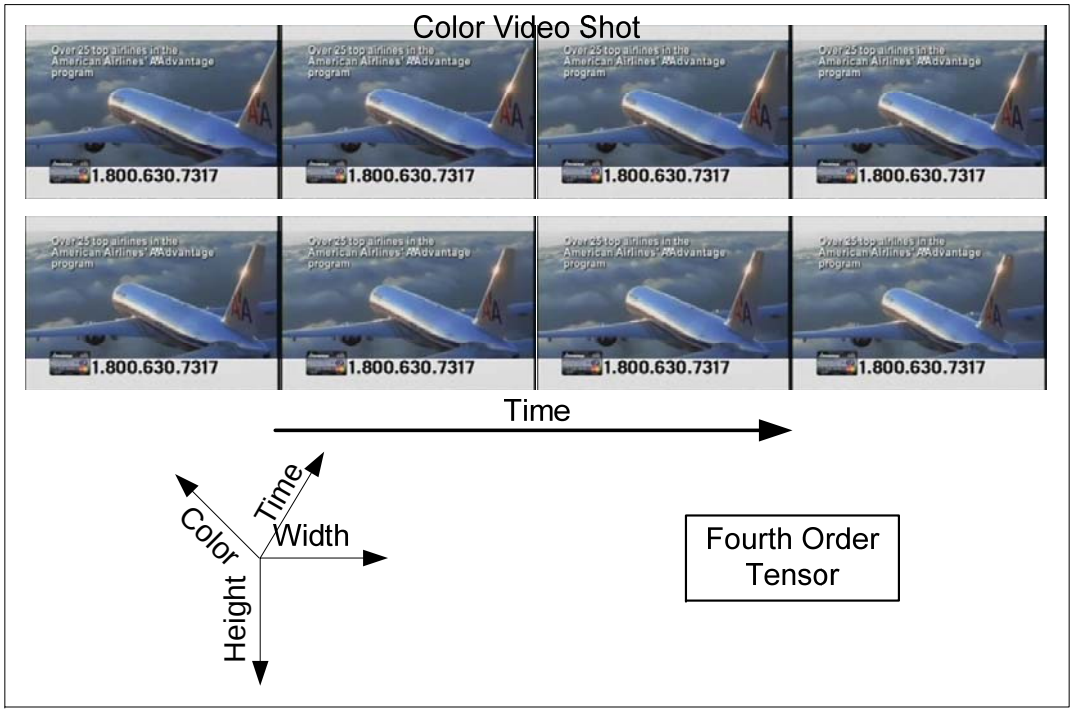
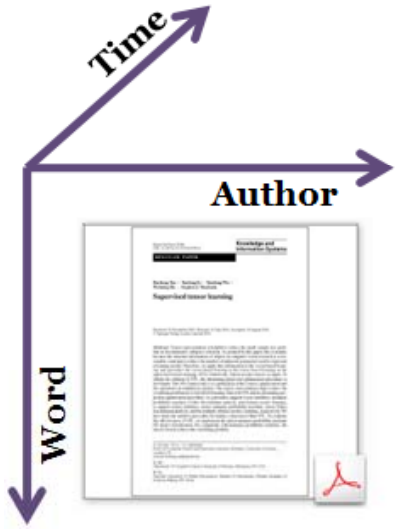
Tensor Examples



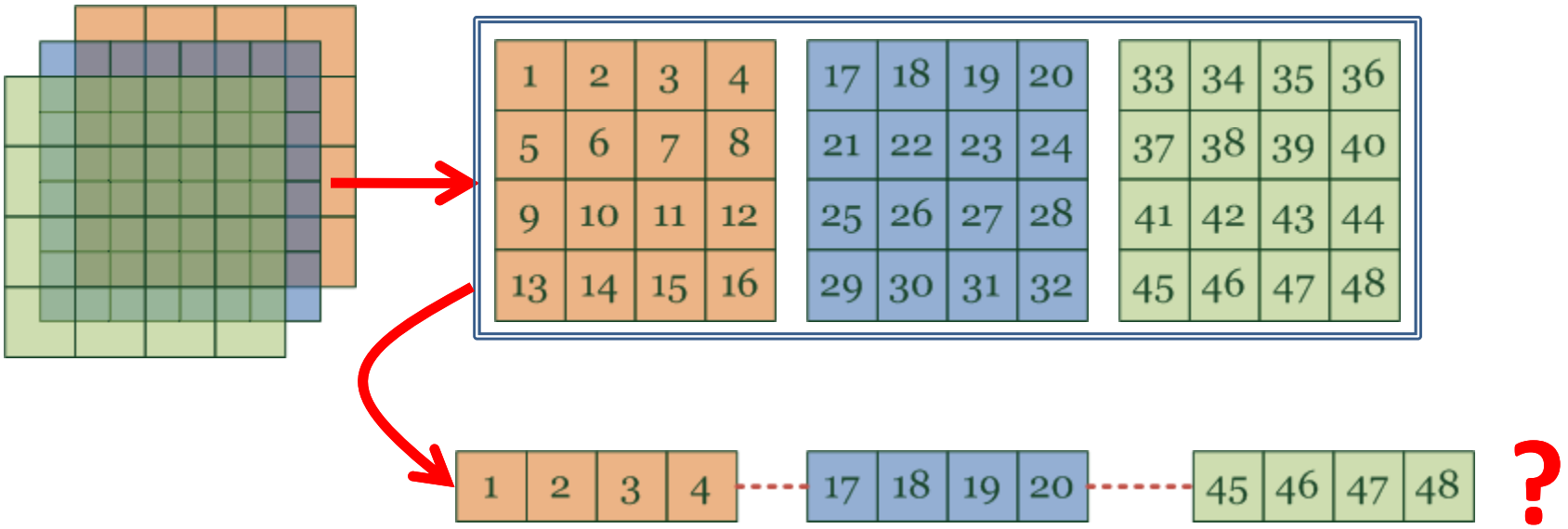




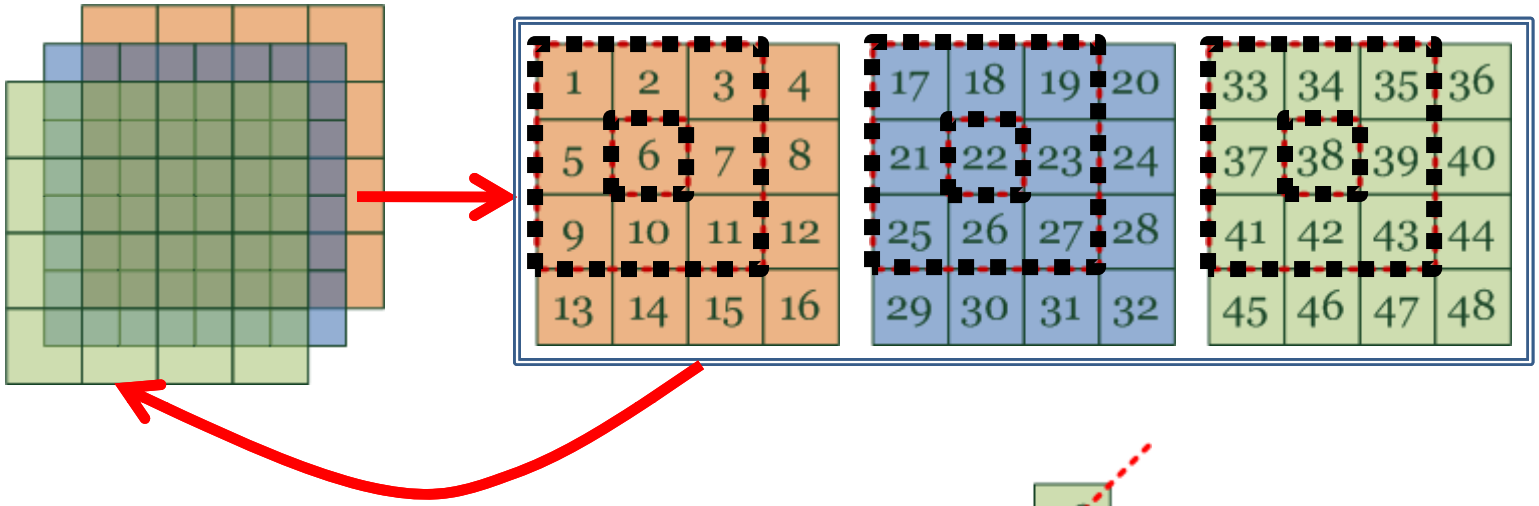


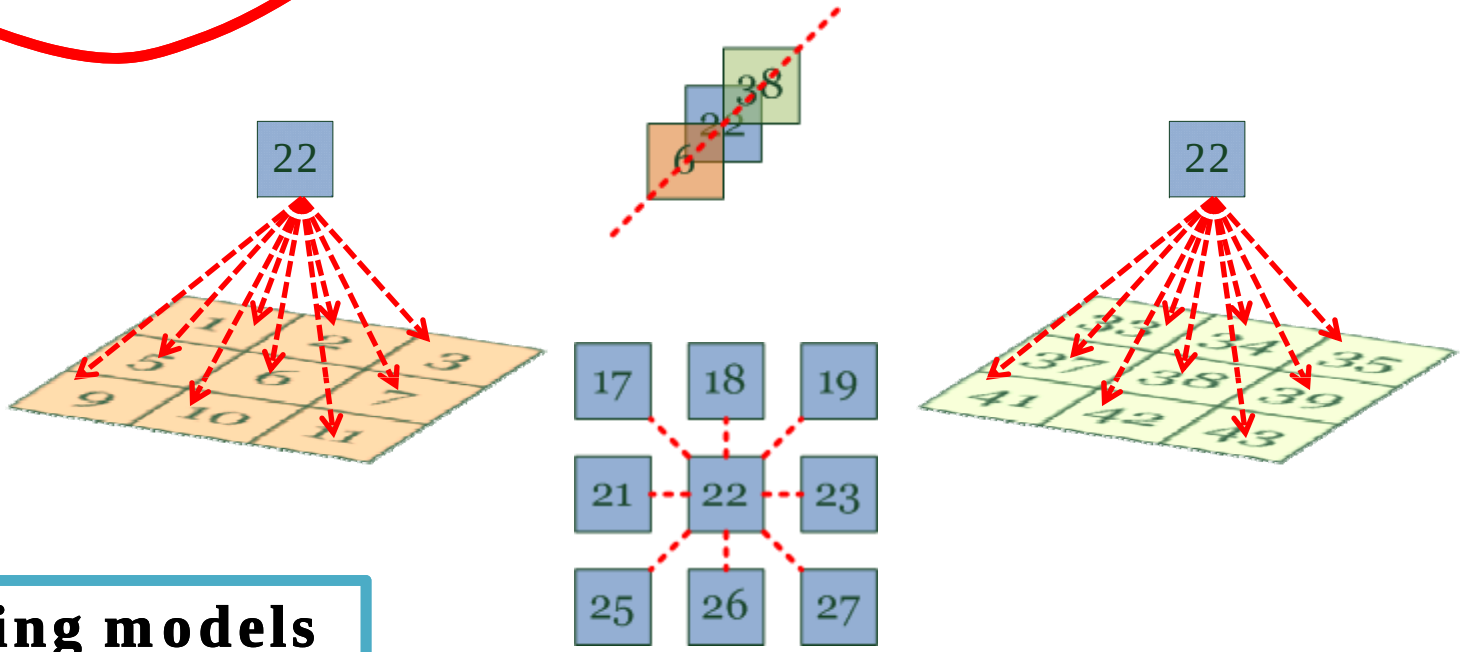
Problem Definition 1

- **Gap: modeling and representation**
  - Algorithms, e.g., PCA, SVM, MPM, LDA…
  - Tensor representation for real objects



Problem Definition 2





Adapt learning models to accept tensors.

Linear and Multilinear

$$A_1 : \mathbf{X} \in R^{L_1 \times L_2 \times \cdots L_M} \mapsto \mathbf{Y}_1 \in R^{L_1' \times L_2' \times \cdots L_M'}$$

$$\mathbf{Y}_1 = \mathbf{X} \times_1 U_1^T \times_2 U_2^T \times \cdots \times_M U_M^T \qquad U_i \in R^{L_i \times L_i'}$$

$$A_2 : \vec{x} = \text{vect}(\mathbf{X}) \mapsto \vec{y}_2 = \text{vect}(\mathbf{Y}_2) \qquad U \in R^{L \times L'}$$

$$\vec{y}_2 = U^T \vec{x}$$

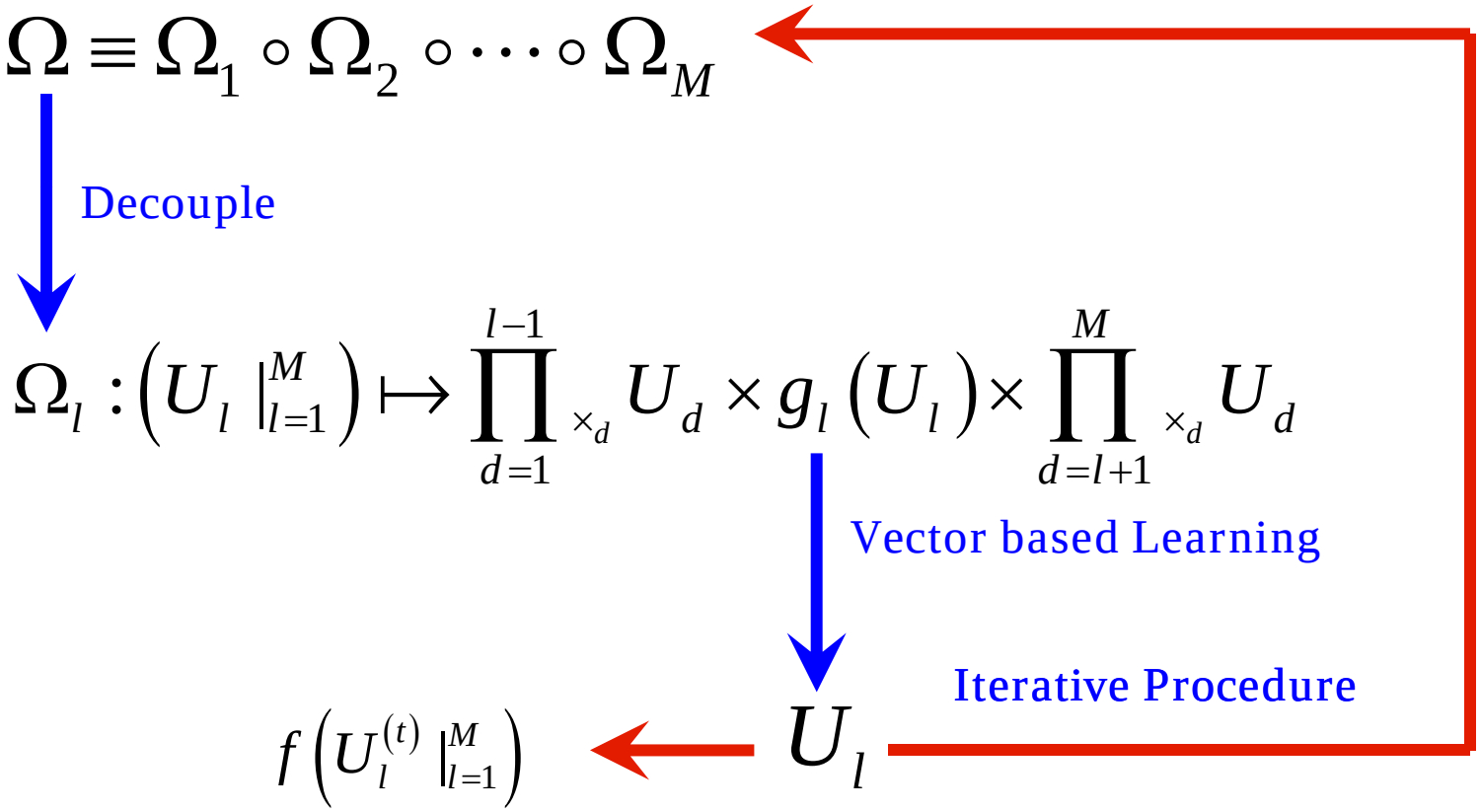
$$U = U_1 \otimes U_2 \otimes \cdots \otimes U_M$$

$$\vec{y}_2 = \vec{y}_1$$

$$\begin{aligned} \vec{y}_1 &= \text{vect}(\mathbf{Y}_1) \\ &= \text{vect}\left(\mathbf{X} \times_1 U_1^T \times_2 U_2^T \times \cdots \times_M U_M^T\right) \\ &= \left(U_1 \otimes U_2 \otimes \cdots \otimes U_M\right)^T \text{vect}(\mathbf{X}). \end{aligned}$$

How to Form an Algorithm

$$\mathbf{X} \in R^{L_1 \times L_2 \times \cdots L_M}$$



Training Convergence Issue

Optimization Method

Questions

- Is it possible to justify tensor based learning machines at the probabilistic level?

- Is it possible to apply the probability theory and to develop probabilistic graphical models for tensors?

- Is it possible to apply the Bayesian inference over specific tensor based learning models?

Related Papers

- Dacheng Tao, Xuelong Li, Xindong Wu and Stephen J. Maybank, “General Tensor Discriminant Analysis and Gabor Features for Gait Recognition,” IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), vol. 29, 2007. [CVPR06]
- Dacheng Tao, Xuelong Li, Xindong Wu, Weiming Hu, and Stephen J. Maybank, “Supervised Tensor Learning,” Knowledge and Information Systems (Springer: KAIS), 2007. [ICDM05]
- Dacheng Tao et al., “Bayesian Tensor Approach for 3D Face Modelling,” IEEE Transactions on Circuits and Systems for Video Technology (TCSVT), 2008. [IJCNN08, ICONIP07]
- Jimeng Sun, Dacheng Tao, Spiros Papadimitriou, Philip Yu, and Christos Faloutsos, “Incremental Tensor Analysis: theory and applications,” ACM Transactions on Knowledge Discovery in Data (ACM TKDD), 2008. [KDD06]

Thanks!

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Questions?