

Final study of a master's thesis

Software Engineer

Signal processing/Machine learning/Acoustic engineering /Optimization problems/Blind Source Separation/Auditory Scene Analysis

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※ Underdetermined Blind Source Separation using Normalized Spatial Covariance Matrix and Multichannel Nonnegative Matrix Factorization

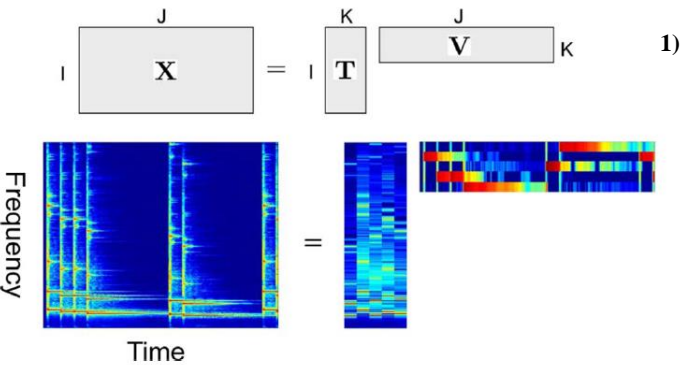


Fig. 1. Formulation of NMF (top) and its application to a music signal (bottom). Frequent sound patterns are identified in matrix T along with their activation periods and strengths shown in matrix V .

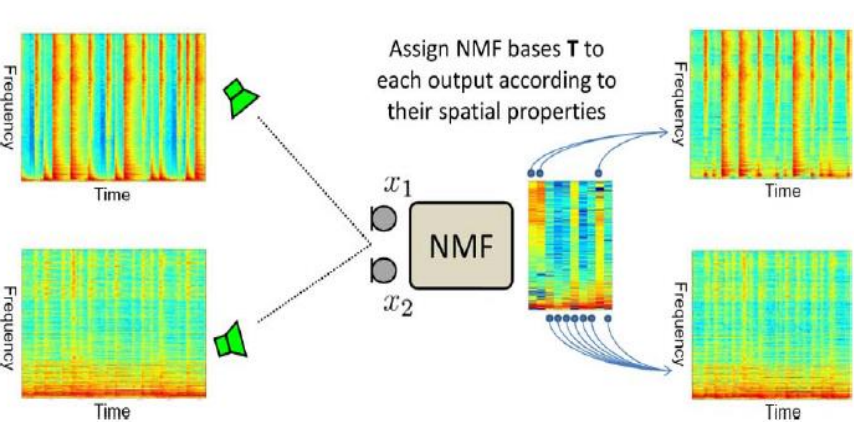
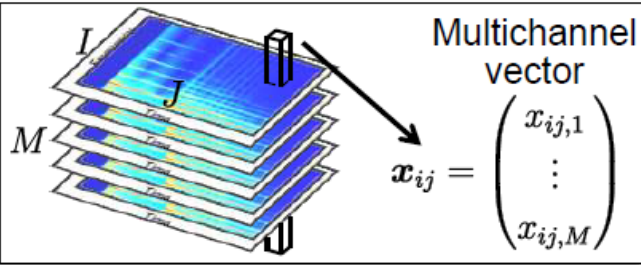


Fig. 2. Multichannel extensions of NMF associate the spatial property with each NMF basis. This enables us to cluster NMF bases according to the source location, and thus perform a source separation task.

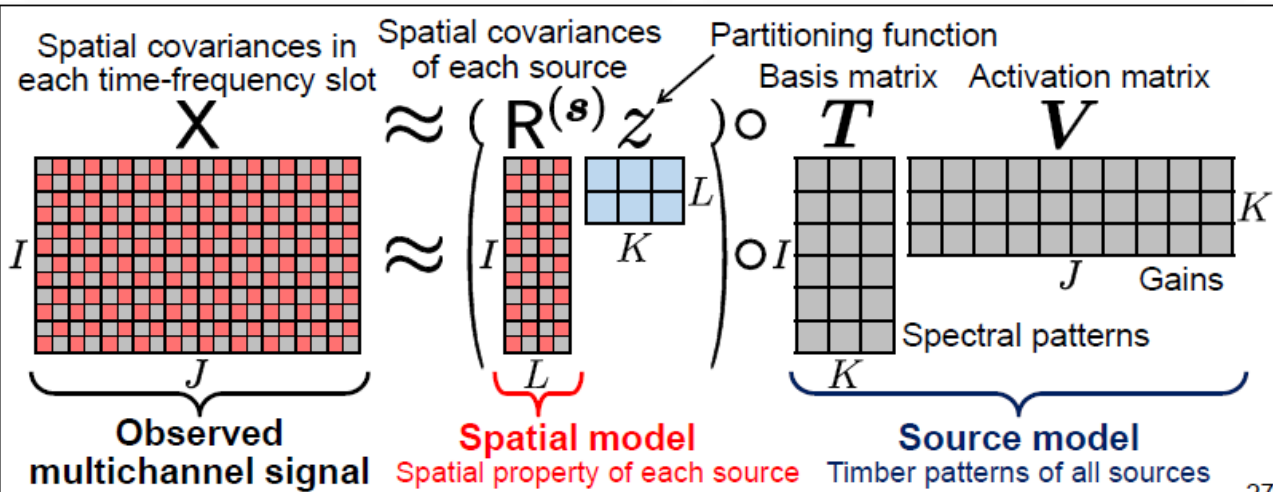
		Multichannel			Single-channel $M = 1$
		Overdetermined $N < M$	Determined $N = M$	Underdetermined $N > M$	
Utilize training data	No	ICA-based techniques		MAP T-F masking	NMF
	Yes	Multichannel NMF (MNMF)			
		Deep Neural Networks (DNNs)			

• Multichannel NMF [A. Ozerov+, 2010], [H. Sawada+, 2013]



Instantaneous spatial covariance

$$\mathbf{X}_{ij} = \mathbf{x}_{ij} \mathbf{x}_{ij}^H$$
$$= \begin{pmatrix} |x_{ij,1}|^2 & \cdots & x_{ij,1} x_{ij,M}^* \\ \vdots & \ddots & \vdots \\ x_{ij,M} x_{ij,1}^* & \cdots & |x_{ij,M}|^2 \end{pmatrix}$$



1) H. Sawada, H. Kameoka, S. Araki and N. Ueda, "Multichannel Extensions of Non-Negative Matrix Factorization With Complex-Valued Data," in IEEE Transactions on Audio, Speech, and Language Processing, vol. 21, no. 5, pp. 971-982, May 2013.

2) D. Kitamura, N. Ono, H. Sawada, H. Kameoka and H. Saruwatari, "Determined Blind Source Separation Unifying Independent Vector Analysis and Nonnegative Matrix Factorization," in IEEE/ACM Transactions on Audio, Speech, and Language Processing, vol. 24, no. 9, pp. 1626-1641, Sept. 2016.

Final Project

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$$X_{ij} = \tilde{\mathbf{x}}_{ij} \tilde{\mathbf{x}}_{ij}^H = \begin{pmatrix} |\tilde{x}_{ij,1}|^2 & \tilde{x}_{ij,1} \tilde{x}_{ij,2}^* \\ \tilde{x}_{ij,2} \tilde{x}_{ij,1}^* & |\tilde{x}_{ij,2}|^2 \end{pmatrix}$$

