TENSOR-BASED BIOSIGNAL PROCESSING

Sabine Van Huffel
Department of Electrical Engineering (ESAT-SCD),
Katholieke Universiteit Leuven,
Kasteelpark Arenberg 10, B-3001 Leuven, Belgium,
e-mail: sabine.vanhuffel@esat.kuleuven.be

Keywords: tensor, PARAFAC, biomedicine, signal processing, multilinear algebra

Abstract

This contribution deals with tensor decompositions and their benefits in biomedical signal processing. After a brief introduction of tensors and their differences with matrices, different decompositions are described and their computational algorithms are introduced as generalizations of matrix-based counterparts. In particular, we will focus on 'Parallel Factor Analysis' (Parafac, also known as Candecomp or the CP model), the most popular tensor decomposition, and overview its mathematical properties. The CP model decomposes in a unique way a higher-order tensor in a minimal sum of rank-1 'atoms'.

Furthermore, we will give an overview of biomedical applications, in which tensors are useful. In particular, we will focus on the presurgical evaluation of refractory partial epilepsy for the delineation of the irritative and ictal onset zones using long-term electroencephalographic (EEG) recordings . We will extract the potential distribution of the ictal activity using the higher-order CP model and show that only one atom is related to the seizure activity.

Acknowledgement: Research supported by Research Council KUL: GOA-AMBioRICS, CoE EF-05-006 Optimization in Engineering, IDO 05-010 EEG-fMRI, several PhD/postdoc & fellow grants; Flemish Government: FWO: PhD and postdoc grants, projects, G.0407.02 (support vector machines), G.0360.05 (EEG, Epileptic), G.0519.06 (Noninvasive brain oxygenation), FWO-G.0321.06 (Tensors in Spectral Analysis), G.0341.07 (Data fusion), research communities (ICCoS, ANMMM); IWT: PhD Grants; Belgian Federal Science Policy Office IUAP P5/22 ('Dynamical Systems and Control: Computation, Identification and Modelling'); EU: BIOPATTERN (FP6-2002-IST 508803), ETUMOUR (FP6-2002-LIFESCIHEALTH 503094), Healthagents (IST-2004-27214, FAST (FP6-MC-RTN-035801); ESA: Cardiovascular Control (Prodex-8 C90242).

References

[1] L. De Lathauwer, B. De Moor, and J. Vandewalle, *Computation of the canonical decomposition by means of a simultaneous generalized Schur decomposition*, SIAM J. Matrix Anal. Appl., 26 (2004), pp. 295–327.

[2] M. De Vos, A. Vergult, L. De Lathauwer, W. De Clercq, S. Van Huffel, P. Dupont, A. Palmini, and W. Van Paesschen, *Canonical decomposition of ictal scalp EEG reliably detects the seizure onset zone*, NeuroImage, to appear.