

# Tensor Networks and their Applications in Deep Learning and Machine Learning

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Tensor decomposition (TD) and their generalizations tensor networks (TNs) are emerging tools in Machine Learning (ML), Big Data Analysis (BDA) and Deep Neural Networks (DNN). Many real-life data can be naturally represented as higher-order tensors, which can be described in distributed and compressed forms by tensor decomposition, with substantially, reduced the number of parameters.

We will present a brief overview of tensor networks architectures, associated efficient learning algorithms, and illustrate their perspective and potential applications. We graphically illustrate models of Tensor Train, Tensor Ring and Hierarchic Tucker, MERA and describe their properties and other promising tensor network decomposition for high order tensors. Particular emphasis will be given to tensor completion, feature extraction, classification, clustering and anomaly detection problems in computational neuro-science, especially brain computer interface. Generalization of PCA, SVD, CCA, PLS, SVM and regression for tensor models will be also discussed.



Andrzej Cichocki received the M.Sc. (with honors), Ph.D. and Dr.Sc. (Habilitation) degrees, all in electrical engineering from Warsaw University of Technology (Poland). He spent several years at University Erlangen (Germany) as an Alexander-von-Humboldt Research Fellow and Guest Professor. He was a Senior Team Leader and Head of the laboratory for Advanced Brain Signal Processing, at RIKEN Brain Science Institute (Japan) and now he is a Professor in the Skolkovo Institute of Science and Technology - SKOLTECH. He is author of more than 500 technical journal papers and 5 monographs in English (two of them translated to Chinese). He served as Associated Editor of, IEEE Trans. on Signals Processing, IEEE Trans. on Neural Networks and Learning Systems, IEEE Trans on Cybernetics, Journal of Neuroscience Methods and he is founding Editor in Chief for Journal Computational Intelligence and Neuroscience. Currently, his research focus on brain computer interface, multiway blind source separation, tensor decomposition and tensor networks for biomedical applications. His publications currently report over 39,000 citations according to Google Scholar, with an h-index of 88. He is Fellow of the IEEE since 2013.