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- Título y descripción del proyecto

Deterministic feature decoupling applied to improving deep neural networks performance

A major problem when extracting discrete features (explicit global functions) from data is their algebraic mutual dependence. Recently, we have devised a method, termed "Nested Normalization", for obtaining decoupled features from given sets of algebraically coupled ones. This method consists in performing an ODE-based sequential feature normalization, which provides, in favorable cases, new features having mutually orthogonal gradients. We have demonstrated in several analysis examples (for texture classification and statistical regression) that such a feature orthogonalization typically has a strongly positive effect on the performance of feature-based analysis tasks. Furthermore, we have also applied it to signal synthesis and style transfer with highly promising results.

In a new research phase, we want to investigate the application of deterministic decoupling to (non-explicit) features automatically learned during the training of deep networks. There are two possible scenarios: in the first one, we started from an already trained convolutional neural network (CNN) define some per-layer features (as spatial averages of neural responses at given layers), and attempt to decouple these features through the different layers. We apply this to improve style transfer. In the second one, we apply the deterministic decoupling concept to try to impose gradient orthogonality to the weights being learned.

* E. Martinez-Enriquez, M. d. M. Gonzalez, and J. Portilla, Deterministic decoupling of global features and its application to data analysis, 2022, https://arxiv.org/abs/2207.02132.1008
* E. Martinez-Enriquez and J. Portilla, Deterministic feature decoupling by surfing invariance manifolds, in ICASSP 2020 - 2020 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2020, pp. 6049–6053. Deterministic Feature Decoupling by Surfing Invariance Manifolds | IEEE Conference Publication | IEEE Xplore
* E. Martínez-Enríquez and J. Portilla, Controlled feature adjustment for image processing and synthesis, in 2020 IEEE 22nd International Workshop on Multimedia Signal Processing (MMSP), 2020,1013 pp. 1–6, https://doi.org/10.1109/MMSP48831.2020.9287164.
* J. Portilla and E. Martinez-Enriquez, Nested normalizations for decoupling global features, in 2018 25th IEEE International Conference on Image Processing (ICIP), Oct 2018, pp. 2112–2116, https://doi.org/10.1109/ICIP.2018.8451508.
* T. Canham, A. Martín, M. Bertalmío, and J. Portilla, “Using decoupled features for photo-realistic style transfer,” SIAM Journal on Imaging Sciences, Submitted, 2022.