Tensor Kernel Approximation

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Many scientific experiments and real-world applications produce multi-dimensional data (e.g. fMRI, EEG). The complexity of multi-dimensional data (tensors) leads to the curse of dimensionality issue. Defining and solving a basic classification machine learning (ML) model for tensor input data is a growing field of research. Generally, these classical ML models work for vector input data, and vectorization of tensor input does not lead to better accuracy (Due to the lost tensorial structure). Therefore, developing computationally efficient (time and storage) and a well-generalized algorithm is important. Although, this generalization and optimizing corresponding objective function are not so obvious.

There have been some advancement in the field and one of the well-known classification ML models known as Support Tensor Machine. The breakdown of STM leads to solving the approximation of tensor kernel function. In the literature different tensor kernel approximations have been introduced for different types of tensor decompositions. As research suggests the Dual Structure-preserving Kernel (DuSK) is so far the best fitting tensor kernel approximation for the STM model. The DuSK kernel is specific to Canonically formated tensor decomposition. Usually, choosing the best tensor decomposition is problem-based selection. Hence, we reach to some questions which we are trying to answer in this work. These are as follows,

1. What makes DuSK the best Kernel approximation?
2. Is there any universal Kernel for all sorts of tensor decompositions?
3. What properties the best Kernel approximation must hold?