Approximation of Kernel using Tensor Train for Feature Extraction

Kirandeep Kour[1] Peter Benner[2] Martin Stoll[3] Sergey Dolgov[4]

There are several applications in science and engineering, where enormous amounts of multi-relational data have been produced. They usually have a complex intrinsic structure. Generally, these data depend on various parameters; hence, they can be interpreted as multidimensional data. Although computational power has been increased drastically over the last decades, a direct treatment, involving such multidimensional data, is still almost impossible due to the curse of dimensionality. This means, the required memory storage for multidimensional data increases exponentially with respect to dimensionality and also the associated computational cost.
Tensors (multi-way arrays) can be considered as an essential tool to mitigate the aforementioned issue. They often provide a natural and compact representation for such massive multidimensional data. There has been a significant advancement in the use of tensor decompositions for feature extraction. The decompositions allow us to select necessary features from a large dimensional feature space.
We make use of the tensor train decomposition for building an algorithm for non-separable multidimensional data, which are, in general, not separable by a linear boundary. Therefore, we exploit Kernelized Support Vector Machines, as a base to our approach. To preserve the input data structure, we directly work with tensors as an input. For the classification in a multidimensional case, we propose a method, the so-called Support Tensor Train Machine, by utilizing the tensor train format, thus not restricting ourselves to rank one tensors. We show the robustness and the efficiency of the proposed method by means of numerical experiments.

[1] https://ieeexplore.ieee.org/document/8100207

[1]Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany
[2]Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany
[3]Technische Universität Chemnitz, Germany
[4]University of Bath, UK