Revisiting Deep Fisher Vectors: Using Fisher Information to Improve Object Classification

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Overview

Our work focuses on enhancing a particular hybrid approach that utilises Fisher kernels [1] derived from the Deep Boltzmann Machines [2] (DBMs) to improve the discrimination power of the Fisher score space in its compact form for kernel extraction. Our improved Fisher Kernel leads to better predictive performance.

Our Contributions

- We demonstrate novel theoretical support for deriving an improved Fisher kernel from a compact DBM using the Fisher information matrix (FIM).
- We empirically show that using an approximated FIM improves the discrimination power of deep Fisher score space on three benchmark data sets: MNIST, USPS and Alphanumeric.
- We interpret the model trained on our improved deep Fisher features using global SHAP values [3], and also discuss the faster convergence rates and reduced computational costs of our approach.

Methodology

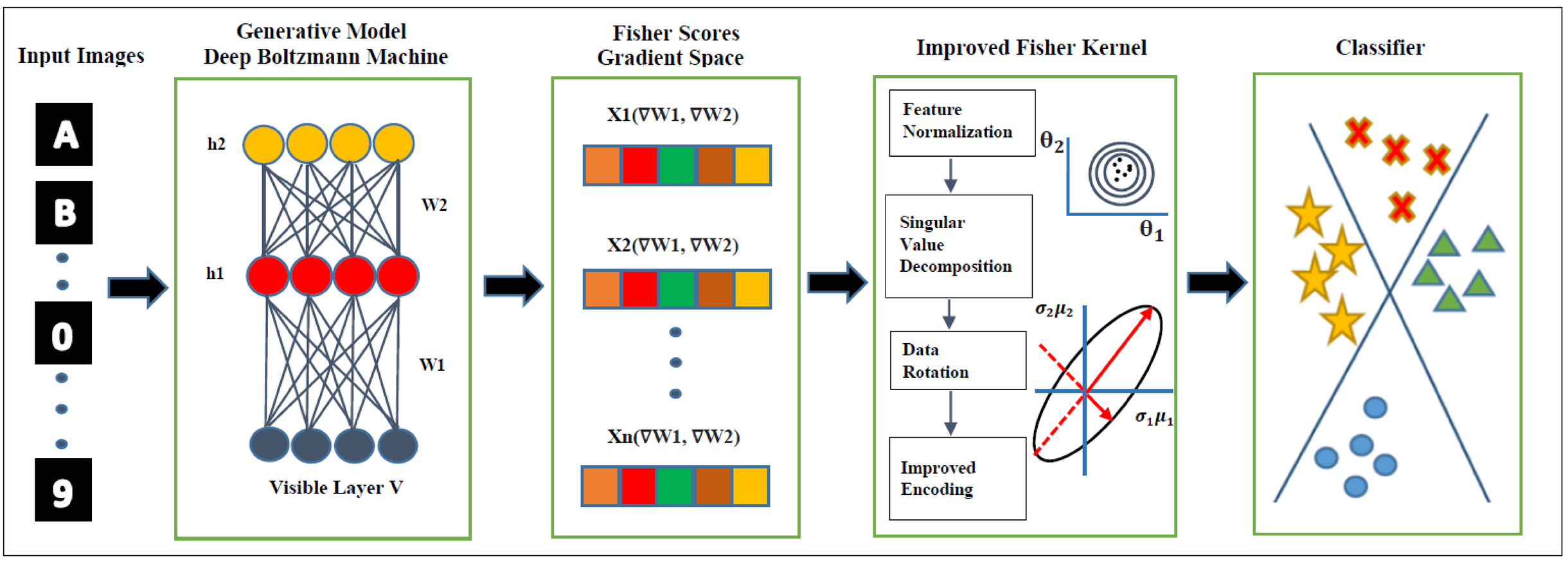

Figure 1: Our proposed framework that bridges the gap between the two popular paradigms of kernel learning and deep learning methods for object classification.

Impact of Fisher Information Matrix on SGD Convergence

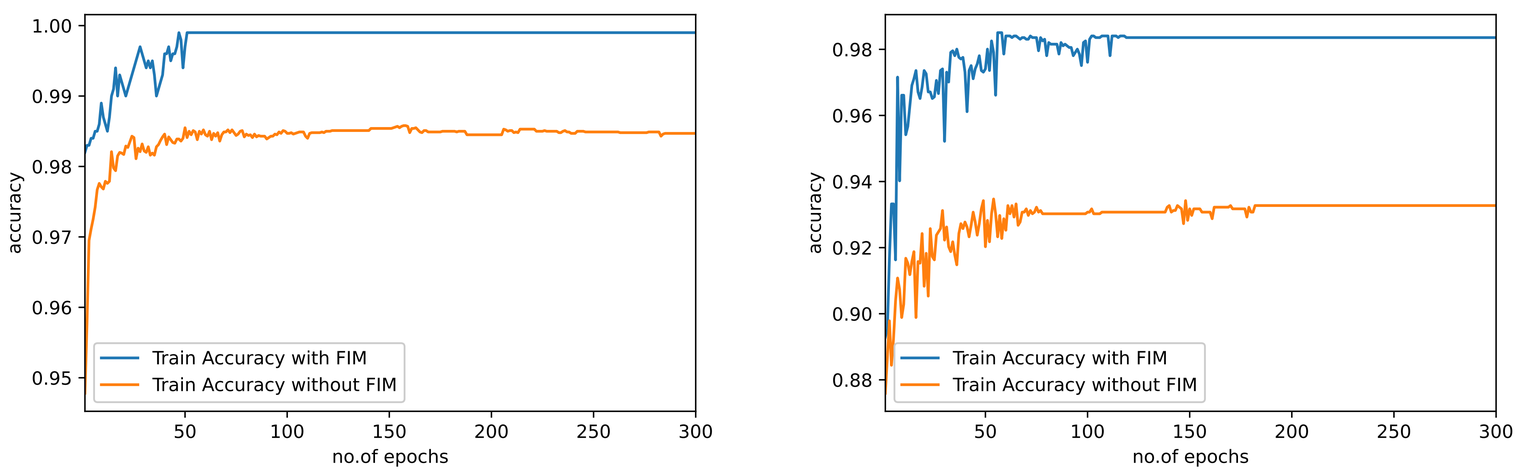

Figure 2: Convergence of SGD for training the SVM classifier on MNIST (left) and USPS (right).

Features Visualization using t-SNE

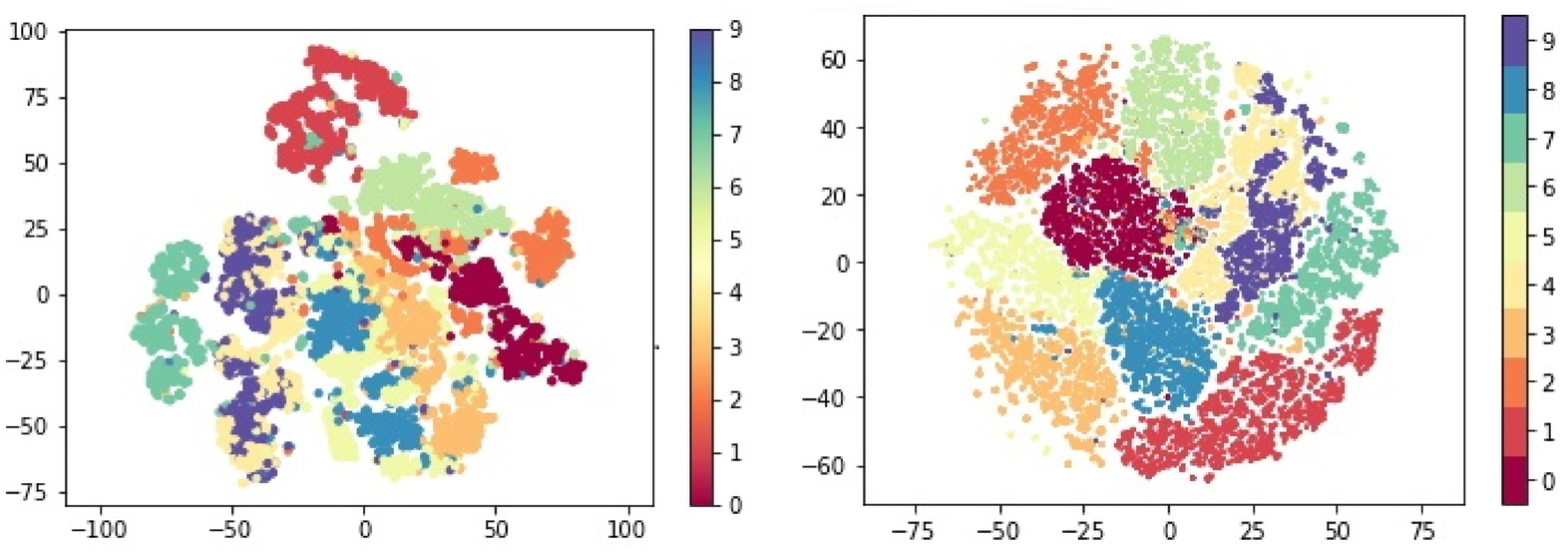

Figure 3: Comparison of the derived Fisher Vectors from DFK (left) and IDFK (right) for MNIST.

Explainability via SHAP

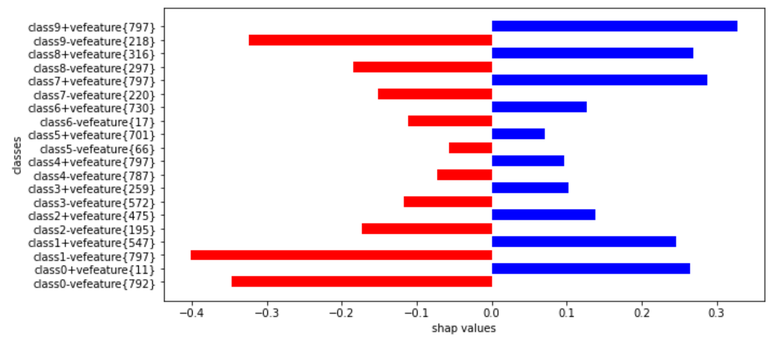

Figure 4: Top supporting and refuting features for each MNIST class for our Improved Deep Fisher Kernel with a k-NN classifier.

Conclusion & Future Work

This work enhances the use of Fisher kernels drawn from the deep Boltzmann machine for visual object classification task. The approach could be further improved by embedding sparsity into the Fisher information matrix. This improvement would reduce the memory footprint of the proposed Fisher vectors enabling it to scale to larger object classification tasks.

References

[1] Martin Sewell. The Fisher Kernel: A Brief Review. *RN*, 11(06):06, 2011.

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[3] Scott M Lundberg and Su-In Lee. A unified approach to interpreting model predictions. *Advances in neural information processing systems*, 30, 2017.

[4] T Azim. Fisher Kernels Match Deep Models. *Electronics Letters*, 53(6):397–399, 2017.

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