Graph Classification: An Application of Higher Order Singular Value Decomposition

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Outline

- Background
- Algorithm
- Numerical Test
How to classify graphs or products?
Algorithm: Training

- Build up tensors
- Tensor decomposition: $\mathcal{X} = G \times_1 A \times_2 B \times_3 C$
- Compute basis matrices: Let $D_v = G(:, :, v) \times_1 A \times_2 B$, then $\mathcal{X} = \sum_{v=1}^{K} D_v \times_3 c_v$
Consider optimization problem for graph $x$ and class $\mu$:

$$\min_{\alpha^\mu_v} \| x - \sum_{v=1}^K \alpha^\mu_v D^\mu_v \|^2$$

Solution: $\alpha^{\mu*}_v = < x, D^\mu_v >$

For each graph $x$ and class $\mu$, compute $R(\mu) = \| x - \sum_{v=1}^K \alpha^{\mu*}_v D^\mu_v \|^2$

Pick the class with smallest $R(\mu)$
Numerical Test: Settings

- Dataset: FashionMNIST (on Kaggle) and MNIST
- Size: 28 × 28 pixels, 60000 graphs in training set and 10000 graphs in test set
- Classes: T-shirt/top, Trouser, Pullover, Dress, Coat, Sandal, Shirt, Sneaker, Bag, Ankle boot
Figure: Error rates with 1 to 20 basis matrices for FashionMNIST and MNIST
**Figure:** First basis matrix for class 1 (Top and T-shirt)

**Figure:** First basis matrix for class 2 (Trouser)
Figure: Basis matrices for class 1 (Top and T-shirt)
Figure: First basis matrix for class 5 (Coat)

Figure: First basis matrix for class 7 (Shirt)
**Figure:** Cosine between the first basis matrix and their respective source tensor for class 5 (Coat) and class 7 (Shirt)
Conclusion

- HOSVD classification algorithm.
- The performance of HOSVD classification on Fashion MNIST is worse than its performance on MNIST.
- Physical meaning of basis matrices.

Next Step:
- Compare with methods such as neural network.
Thank you!