CSE 847 (Spring 2022): Machine Learning
Intermediate Report

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1. **Project Title:**
   A Comparison of Various Randomized Higher Order Singular Value Decomposition (HOSVD) Algorithms

2. **Team Members:** Wei-Chien Liao, Shihab Shahriar Khan

3. **Introduction and Problem Description:**
   Many applications in data sciences require processing high-order tensor data. To deal with large tensor data, dimensionality reduction techniques play an important role among many other types of algorithms. However, performing dimension reduction operations like Tucker decomposition and High Order Singular Value Decomposition (HOSVD) with deterministic algorithms are not efficient for handling large tensor data. This inefficiency can be handled by randomized algorithms. This type of algorithms accelerate classical decompostions by reducing computational complexity of deterministic methods and communications among different level of memory hierarchy. This project aims to study, implement and compare many variants of randomized algorithms, and test them with different datasets from applications such as handwritten digit classification, computer vision or signal processing to evaluate their performances.

4. **Description of the data used in the project:**

   (a)

   (b)

   (c)

5. **What have done so far:**

   (a) Study the papers [1] and [2].

   (b) Explore the Tensor Toolbox for MATLAB.

6. **What remains to be done:**

   (a) Implement the randomized algorithms in [1] and test them with the datasets listed in the "Description of the data" section.

   (b)

7. **Paper List:**

   [1] Salman Ahmadi-Asl, Stanislav Abukhovich, Maame G. Asante-Mensah, Andrzej Cichocki, Anh Huy Phan, Tohishisa Tanaka, and Ivan Oseledets. Randomized algorithms for computation of tucker decomposition and higher order SVD (HOSVD). IEEE Access, 9:28684–28706, 2021

   [2] Tamara G. Kolda and Brett W. Bader. Tensor decompositions and applications. SIAM Review, 51(3):455–500, 2009

   [3] Linjian Ma and Edgar Solomonik. Fast and accurate randomized algorithms for low-rank tensor decompositions. In A. Beygelzimer, Y. Dauphin, P. Liang, and J. Wortman Vaughan, editors, Advances in Neural Information Processing Systems, 2021

   [4] Tamara G. Kolda et al. Brett, W Bader. Tensor toolbox for matlab, version 3.2.1, www.tensortoolbox.org, 4 2021

   [5] Rachel Minster, Arvind K. Saibaba, and Misha E. Kilmer. Randomized algorithms for low-rank tensor decompositions in the tucker format. SIAM Journal on Mathematics of Data Science, 2(1):189–215, 2020