Impromptu Tensor Discussion

CSE17

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CROWD-SOURCED TALK

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Why tensors? Current Applications? Future Applications?

- Quantum chemistry

- Data analytics

- Statistics

- Engineering

- Health care analytics

- Sparse versus dense

- PDEs with unknowns that are tensors – operator theory

- Multi-fidelity, associated with rank, rare events – Modeling rare events

Key Kernels/Computational Bottlenecks/Data Structures

- MTTKRP

- TTM

- Matricization/unfolding

- SVD of unfolded tensor

- In-place algorithms (i.e., avoid data movement)

- Coupled tensor decomposition – bringing in different types of constraints

- Tensor contractions for dense, sparse, and block sparse

- Methods including permutational symmetry

- Data structures for sparse tensors

- Khatri-Rao product – not tensor operation but sometimes need to build it explicitly

- Need interface standardization ala BLAS

- How to optimize operations in a general framework for dense, sparse, symmetric, etc.

Needed Understanding, Algorithms, Methods

- Steaming data – network data, partial computation?

- Updating tensor decomposition

- How to choose the data layout for general sparse tensor?

- Tensor completion – how many samples do you really need?

- Sparsity-preserving computations – sparse factors

- Global optimization

Theoretical, Algorithmic, Understanding Challenges?

- Rank estimation

- Connections between tensors & deep learning (new program just started in Moscow!)

- Use of tensors inside neural networks

- Alternative decomposition algorithms – beyond ALS

- DMRG/Tensor Train in quantum – why does it work so well? How to expand to other tensor networks?

- Theoretical framework to understand how to do the quantitization

- Visualization of factorizations?

- Also, how to identify what the components mean, choosing constraints, etc. Maybe a generic framework.

- Which model to choose for which application? Choose based on fit? Based on interpretability?

What Training for Tensors?

- Are there things we can do to cross pollinate between tensor contraction and tensor decomposition folks?
  - Dimensions, contractions, ranks
  - Explicit labeling of modes/Einstein notation
  - Explicit translation paper? Workshop?
    (NSF workshop in May??)

- Need listing of existing books and survey papers

- Need better Wikipedia articles!
  - "Tensor" is polymorphic

- Recommended coursework
  - Numerical linear algebra
  - Optimization
  - Differential geometry
  - Selected topics in biomedical data processing – subspaces with interpretation

- TensorFlow tutorials for MD arrays