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Research Statement:

My research directions are based on the following areas, recently dictated in part by short-term grant selections (from recently successful SBIR and BAA funding opportunities) and from previous academic engagements:

- Data compression (particularly block based methods, methods for integer and floating point data, and algorithms which scale well on parallel architectures). Higher resolution multimedia content is especially needy of more advanced and more efficient compression algorithms and there are strong ground to combine deep learning methods with traditional information theory based approaches.
- Dimensionality reduction, feature discovery, and data visualization for large scale data. Randomization based approaches are particularly well suited for data sets with redundancy, which manifests itself via nonlinear singular value decay in data matrices or higher dimensional tensors. These operators tend to have a narrow range which can be efficiently sampled with blocks of random vectors to create lower dimensional approximants and reveal key data features. Specialized factorizations can be useful for visualization and feature extraction. Also of interest are autoencoder type schemes for obtaining automatic feature finger prints from data.
- Image enhancement with a combination of machine learning and optimization based schemes. Of particular interest are situations where objects are partially obscured due to degradations due to the imaging process (passive or active) or to environmental conditions. Optimization schemes arising from compressive sensing field developments can be combined with deep learning methods.
- Statistical and machine learning methods for time series feature extraction and prediction techniques. In particular, of interest are optimized Gaussian Process regression based schemes, the use of multi-fidelity data merging methods, and approaches using long short term memory network architecture.
- Parallelized implementation and HPC computing. Of particular interest is the concurrent use of one or multi-node systems each with multi-core processors, GPU and/or FPGA devices. For example, for parallel data compression with large inputs can benefit from data permutation methods based on clustering, where operations can be efficiently split across multiple nodes and GPU devices. Similar approaches can be applied to dimensionality reduction.

Sincerely,
Sergey
03.21.2022