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Title: « An Adaptive Sublinear-Time Block Sparse Fourier Transform »

Abstract:
The problem of approximately computing a small number k of dominant Fourier coefficients of a vector of length n quickly, and using few samples in time domain, is known as the Sparse Fourier Transform (sparse FFT) problem. A long line of work on the sparse FFT has resulted in algorithms with $O(k\log n\log (n/k))$ runtime and $O(k\log n)$ sample complexity. These results are proved using non-adaptive algorithms, and the latter sample complexity result is essentially the best possible under the sparsity assumption alone: It is known that even adaptive algorithms must use $\Omega((k\log(n/k))/\log\log n)$ samples. By {\em adaptive}, we mean being able to exploit previous samples in guiding the selection of further samples.

In this work we revisit the sparse FFT problem with the added twist that the sparse coefficients approximately obey a $(k_0,k_1$)-block sparse model. In this model, signal frequencies are clustered in k_0 intervals with width k_1 in Fourier space, where $k= k_0k_1$ is the total sparsity. Signals arising in applications are often well approximated by this model with $k_0\ll k$.

We give the first sparse FFT algorithm for (k_0, k_1)-block sparse signals with the sample complexity of $O^*(k_0k_1 + k_0\log(1+ k_0)\log n)$ at constant signal-to-noise ratios, and sublinear runtime. A similar sample complexity was previously achieved in the works on {\em model-based compressive sensing} using random Gaussian measurements, but used $\Omega(n)$ runtime. To the best of our knowledge, our result is the first sublinear-time algorithm for model based compressed sensing, and the first sparse FFT result that goes below the $O(k\log n)$ sample complexity bound.

Joint work with Volkan Cevher, Jonathan Scarlett and Amir Zandieh.