ESPIRA method for the recovery of exponential sums

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We introduce a new method - ESPIRA (Estimation of Signal Parameters via Iterative Rational Approximation) [1, 2] - for the recovery of complex exponential sums

$$f(t) = \sum_{j=1}^{M} \gamma_j \mathrm{e}^{\lambda_j t},$$

that are determined by a finite number of parameters: the order M, weights $\gamma_j \in \mathbb{C} \setminus \{0\}$ and nodes $\mathrm{e}^{\lambda_j} \in \mathbb{C}$ for $j = 1, ..., M$. Our new recovery procedure is based on the observation that Fourier coefficients (or DFT coefficients) of exponential sums have a special rational structure. To reconstruct this structure in a stable way we use the AAA algorithm proposed by Nakatsukasa et al. [3]. We show that ESPIRA can be interpreted as a matrix pencil method applied to Loewner matrices. During the talk we will demonstrate that ESPIRA outperforms Prony-like methods such as ESPRIT for noisy data and for signal approximation by short exponential sums.

References

[1] N. Derevianko, G. Plonka, Exact reconstruction of extended exponential sums using rational approximation of their Fourier coefficients, Anal. Appl., **20**(3), 2022, 543-577.

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[3] Y. Nakatsukasa, O. Sète, L.N. Trefethen, The AAA algorithm for rational approximation. SIAM J. Sci. Comput., **40**(3), 2018, A1494–A1522.