

Sparse Interpolation in CS&E

Annie Cuyt

University of Stirling, UK

University of Antwerp, Belgium

30th Applications of Computer Algebra - ACA 2025

What is called Sparse Interpolation (SI) in computer algebra is termed Exponential Analysis (EA) in signal processing. The respective goal is to identify and reconstruct a sparse linear combination of monomials or a sparse linear combination of exponential functions.

We discuss how SI and EA can cross-fertilize and lead to new results in several Computational Science and Engineering problem statements. Among other things, we discuss antenna design [6], torsional vibration, radioastronomy metrics [7], financial time series analysis, fluorescence lifetime imaging [8], direction of arrival [3], localisation problems [4] and [5], texture analysis [2], radar imaging [1],...

References

- [1] A. Cuyt, Y. Hou, F. Knaepkens, and W.-s. Lee. Sparse multidimensional exponential analysis with an application to radar imaging. *SIAM J. Scient. Comp.*, 42:B675–B695, 2020.
- [2] Y. Hou, A. Cuyt, W.-s. Lee, and D. Bhowmik. Decomposing textures using exponential analysis. In *IEEE ICASSP 2021 Proceedings*, 1920–1924, 2021.
- [3] F. Knaepkens, A. Cuyt, W.-s. Lee, and D.I.L. de Villiers. Regular sparse array direction of arrival estimation in one dimension. *IEEE Trans. Antennas Propag.*, 68:3997–4006, 2020.
- [4] R. Louw, F. Knaepkens, A. Cuyt, W.-s. Lee, S. J. Wijnholds, D.I.L. de Villiers, and R.-M. Weideman. Antenna position estimation through sub-sampled exponential analysis of signals in the near-field. *URSI Radio Science Letters*, 3, 2021.
- [5] R. Louw, R.-M. Weideman, D.I.L. de Villiers, A. Cuyt, and S. J. Wijnholds. Antenna position estimation results from in-situ measurement data. In *2023 International Conference on Electromagnetics in Advanced Applications (ICEAA)*, 2023.
- [6] R. Sengupta, A. Cuyt, F. Knaepkens, D. S. Prinsloo, T. Schäfer, and A. Bart Smolders. A fast exponential analysis and variable projection based method for linear array synthesis. *IEEE Antennas and Wireless Propagation Letters*, 2025.
- [7] R.-M. Weideman, A. Cuyt, and D.I.L. de Villiers. Characterising the electric field ripple in reflector antennas using sub-sampled exponential analysis. *IEEE Transactions on Antennas and Propagation*, 72(7):5511–5519, 2024.
- [8] Y. Zhang, A. Cuyt, W.-s. Lee, G. Lo Bianco, G. Wu, Y. Chen, and D. D.-U. Li. Towards unsupervised fluorescence lifetime imaging using low dimensional variable projection. *Opt. Express*, 24(23):26777–26791, 2016.