



Announces the Ph.D. Dissertation Defense of

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for the degree of Doctor of Philosophy (Ph.D.)

“On Time-Series Analysis by Structured Matrix Decompositions with Applications to Signal Direction-of-Arrival Estimation”

April 22nd, 2026, at 10:00 AM
Engineering East (EE-96), Room 303
777 Glades Road, Boca Raton, FL

DEPARTMENT: Electrical Engineering and Computer Science

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ABSTRACT OF DISSERTATION

Modern autonomous systems operating in highly dynamic, non-stationary environments require reliable inference from short, potentially corrupted time-series measurements, where conventional statistical methods relying on large-sample support and stationarity assumptions become fundamentally inapplicable. This dissertation develops a unified, model-free theoretical framework for time-series analysis, with a particular application to signal Direction-of-Arrival (DoA) estimation, grounded in structured matrix decompositions under both the L_2 -norm and L_1 -norm formulations.

We first approach the problem from a conventional viewpoint by carrying out standard matrix analysis directly on Hankel-structured representations of time-series data. In this context, we demonstrate that L_1 -norm decompositions of Hankel matrices offer strong resistance to partially faulty or missing sensor measurements, yielding a principled framework for robust real-time monitoring and operation of autonomous systems. Pursuing this line of inquiry, we introduce a novel one-shot DoA estimator that operates directly on a single antenna-array sample via structured matrix representations and singular-value decomposition (SVD). Arguably surprisingly, the proposed estimator can achieve lower mean-square error, bias, and variance when compared against the classical Maximum Likelihood single-sample estimator under white Gaussian noise. The effectiveness of the proposed one-shot estimator is further validated using real-world massive MIMO measurements from the POWDER-RENEW platform.

Next, we depart from conventional decompositions of Hankel-structured representations and turn our attention to the general and broadly applicable problem of computing optimal structured Hankel and Toeplitz decompositions of arbitrary matrices, jointly enforcing the low-rank and the corresponding structure constraints. We develop accurate and computationally efficient algorithms for rank-1 Hankel and Toeplitz-structured decompositions under both the L_2 -norm and L_1 -norm formulations, and derive analytically grounded few-



shot DoA estimators for practical sensing architectures in which the sensed array measurement matrix does not possess Hankel structure, while the underlying signal of interest inherently does. The proposed rank-1 estimators under the L_2 and L_1 norms are formally shown to be maximum-likelihood-optimal under white Gaussian and Laplace noise, respectively. Beyond theoretical guarantees and controlled simulations, the robustness of the L_1 -based estimator is further demonstrated using real-world outdoor Unmanned Aerial Vehicle (UAV) measurements.

Extending this framework to the multi-signal case, we further develop few-shot DoA estimators based on rank-K Hankel matrix decompositions under both the L_2 and L_1 norm formulations. The rank-K estimator under the L_2 -norm retains its maximum-likelihood optimality under white Gaussian noise, while under the L_1 -norm, we obtain a novel, robust estimator that is highly resilient to impulsive interference. Extensive simulations demonstrate that the proposed methods achieve hyper-resolution capabilities, requiring significantly lower signal-to-noise ratio and attaining substantially higher probability of resolution compared to competing approaches.

BIOGRAPHICAL SKETCH

Born in Thessaloniki, Greece

B.S., Computer Science with minor in Mathematics, Winthrop University, Rock Hill, SC, USA, 2021

M.S., Artificial Intelligence, Florida Atlantic University, Boca Raton, FL, USA, 2023

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CONCERNING PERIOD OF PREPARATION & QUALIFYING EXAMINATION

Time in Preparation: 2021-2026

Qualifying Examination Passed: Spring 2023

Published Papers:

- [G. I. Orfanidis](#), D. A. Pados, G. Sklivanitis, E. S. Bentley, "Few-shot Hyper-resolution Signal Direction-of-Arrival Estimation with Rank-K Hankel-structured Decompositions", submitted to *IEEE Transactions on Signal Processing*, Apr. 2026.
- [G. I. Orfanidis](#), D. A. Pados, G. Sklivanitis, E. S. Bentley, "Hankel and Toeplitz Rank-1 Decomposition of Arbitrary Matrices with Applications to Few-shot Signal Direction-of-Arrival Estimation", submitted to *IEEE Transactions on Signal Processing*, Apr. 2026.
- S. Mazokha, S. Naderi, [G. I. Orfanidis](#), G. Sklivanitis, D. A. Pados, and J. O. Hallstrom, "Single-sample Direction-of-Arrival Estimation for Fast and Robust 3D Localization with Real Measurements from a Massive MIMO system", in Proc. *ICASSP 2023 - 2023 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Rhodes Island, Greece, Jun. 2023, pp. 1-5, doi: 10.1109/ICASSP49357.2023.10096647.
- [G. I. Orfanidis](#), D. A. Pados, G. Sklivanitis, E. S. Bentley, Joseph Suprenant, M. J. Medley, "Single-sample Direction-of-Arrival Estimation by Hankel-matrix Decompositions", in Proc. *2022 56th Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Oct. 2022, pp. 1026-1030, doi: 10.1109/IEEECONF56349.2022.10051870.
- [G. I. Orfanidis](#), D. A. Pados, G. Sklivanitis, "Time-series Analysis with Small and Faulty Data: L1-norm Decompositions of Hankel Matrices", in Proc. *SPIE Defense + Commercial Sensing on Big Data IV: Learning, Analytics, and Applications*, Orlando, FL, April 2022, pp. 97-104, doi: 10.1117/12.2619243.