



UNIVERSITÀ DI PISA
DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

“Multivariate Statistical Signal Processing with Applications to Radar Systems”

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Short Abstract: This course provides an overview of the main and powerful tools for adaptive radar detection and clutter estimation in the context of multivariate statistical theory. Specifically, starting from the derivation of the signal and interference discrete time signal models, the course will focus on the design of disturbance parameter estimation techniques and target detection architectures grounded on the maximum likelihood approach and suitable modifications of it. The obtained decision rules will be assessed by deriving closed-form expressions for the probability of detection and probability of false alarm. Even though the specific examples are related to radar systems, this course will provide the students with rather general concepts that exhibit a broad application field.

Course Contents in brief:

- See time schedule.

Total # of hours of lecture: 16

References:

- [1] H. L. Van Trees, , Optimum Array Processing (Detection, Estimation, and Modulation Theory, Part IV), John Wiley & Sons, 2002.
- [2] S. M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory (Vol. 1), Hall, Prentice (Ed.), 1993.
- [3] S. M. Kay, Fundamentals of Statistical Signal Processing: Detection Theory (Vol. 2), Hall, Prentice (Ed.), 1998.
- [4] F. Bandiera, D. Orlando, G. Ricci, Advanced Radar Detection Schemes Under Mismatched Signal Models, Synthesis Lectures on Signal Processing No. 8, Morgan & Claypool Publishers: San Rafael, US, 2009.

CV of the Teacher

Danilo Orlando was born in Gagliano del Capo, Italy, in 1978. He received the Dr. Eng. degree (with honors) in computer engineering and the Ph.D. degree (with maximum score) in information engineering from the University of Salento (formerly University of Lecce), Lecce, Italy, in 2004 and 2008, respectively. From 2007 to 2010, he was with the University of Cassino, Cassino, Italy, engaged in a research project on algorithms for track-before-detect of multiple targets in uncertain scenarios. From September to November 2009, he was a Visiting Scientist with the NATO Undersea Research Centre, La Spezia, Italy. From 2011 to 2015, he was with Elettronica S.p.A. engaged as System Analyst in the field of electronic warfare. From 2015 to 2024, he joined an University of Rome, Italy, as an Associate Professor. From 2024, he is an Associate Professor with the Department of Information Engineering, Università degli Studi di Pisa, Pisa, Italy. In 2007, he has held visiting positions with the Department of Avionics and Systems, ENSICA (now Institut Supérieur de l'IAéronautique et de l'Espace (ISAE)), Toulouse, France, and from 2017 to 2019, with the Chinese Academy of Science, Beijing, China. He has authored or coauthored more than 210 scientific publications in international journals, conferences, and books. His main research interests include statistical signal processing with more emphasis on adaptive detection and tracking of multiple targets in multisensor scenarios. Dr. Orlando was Senior Area Editor for IEEE TRANSACTIONS ON SIGNAL PROCESSING and is currently Senior Area Editor for IEEE Open Journal of Signal Processing, an Associate Editor for IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS, IEEE SENSORS, EURASIP Journal on Advances in Signal Processing, and Remote Sensing (MDPI).

Final Exam: presentation and discussion of a scientific paper related to the topics of the course

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule:

Day 1 (08/05/2026): Estimation Theory (3 hours) (14:30-17:30).

Day 2 (15/05/2026): Estimation of non random parameters (3 hours) (14:30-17:30).

Day 3 (22/05/2026): Direction of Arrival Estimation (4 hours) (14:30-18:30).

Day 4 (29/05/2026): Estimation of random parameters and spatial filtering (3 hours) (14:30-17:30).

Day 5 (12/06/2026): Detection Theory (3 hours) (14:30-17:30).