

Keynote 01: Optimization Methods in Computational Intelligence for Joint Wireless Channel Parameter Estimation over Advanced Radio Interface Technologies

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ABSTRACT

Advanced Radio Interface Technologies (RITs) combine broadband signalling—hence multi-carrier operation and richly multipath propagation—with multi-antenna transceivers. In these regimes, joint estimation of channel parameters (angles of arrival/departure, delays, Doppler/frequency offsets, gains/phases, etc.) becomes a central yet challenging inference problem. Objective or cost functions are often nonconvex, multimodal, and simulator-defined, with scarce gradients, tight pilot budgets, and low signal-to-noise ratios (SNRs). Therefore, among computational intelligence (CI) categories that encompass 1) neural networks and 2) fuzzy systems, the third or 3) population-based and bioinspired optimization (PBO/BO) methods – such as particle swarm optimization (PSO), differential evolution (DE), genetic algorithms (GA), grey wolf optimizer (GWO), and related swarms – have gained traction as global search engines that either directly minimize maximum-likelihood (ML) or mean-square error (MSE) criteria or act as robust initializers for hybrid pipelines. In this talk, first we integrate a disciplinary taxonomy relating artificial intelligence (AI), optimization, and Monte Carlo inference to place CI and PBO/BO within a broader computational context worth contemplating. Then we survey the current state of the art on CI optimization for wireless channel parameter estimation and analyze the strengths and weaknesses of each CI subcategory versus the others and against conventional estimation methods. We synthesize algorithmic patterns, objectives, accuracy, convergence/complexity trends, and empirical findings, etc., over advanced RITs, and we discuss most recent progress and open challenges.

BIOGRAPHY



Sofiene Affes received the Engineering Diploma in Telecommunications and the Ph.D. Degree (Hons.) in Signal Processing from Telecom Paris-Tech (ENST), Paris, France, in 1992 and 1995, respectively. He has been since with INRS, Montreal, QC, Canada, as a Research Associate until 1997, an Assistant Professor until 2000, an Associate Professor until 2009, and from then on as a Full Professor. From, 2013 till 2019, he was the Director of PERWADE, a unique 4M\$ research-training program on wireless in Canada involving 27 academic and industrial partners from 8 universities and 10 industrial organizations. Dr. Affes has been twice the recipient of a Discovery Accelerator Supplement Award from NSERC, from 2008 to 2011 and from 2013 to 2016. From 2003 to 2013, he held a Canada Research Chair in Wireless Communications. And from 2017 to 2022, he was the recipient of a Cyrille-Duquet Research

Chair in Telecommunications. In 2008 and 2015, he received the VTC and ICUWB Chair Recognition Award and Certificate from IEEE VTS and MTT-S, respectively, for exemplary contributions as General Co-Chair to the success of both conferences held at their Fall 2006 and 2015 editions in Montreal. In 2017, he served as General Chair of IEEE PIMRC also held in Montreal. His team received Best Paper Awards at IEEE Globecom, IEEE ICASSP, and IEEE VTC. He has been or is currently an Editorial Board Member for the IEEE Transactions on Communications, Signal Processing, and Wireless Communications, for the Wiley Journal on Wireless Communications & Mobile Computing, the MDPI Sensors and Sci Journals, and the Electronics and Signal Processing Journal.