

# Universal Adaptive Beamformers: Machine Learning Meets Array Processing

*Professor John R. Buck of the University of Massachusetts Dartmouth*



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One of a series of talks on Artificial Intelligence and Machine Learning that are jointly sponsored by Metron, Inc. and George Mason University.

## ABSTRACT

Practical adaptive beamformers operating in dynamic environments regularize the estimated sample covariance matrix. All common regularization techniques require the system designer to choose a critical parameter such as the diagonal loading level, the subspace dimension, or averaging window length. Given a full data set, one can process offline in batch mode to find the optimal regularization parameter, but it is a difficult open challenge to find the best regularization in real time. The universal adaptive beamformer (UABF) combines online learning techniques with array processing to create a new beamforming framework that adapts the regularization parameters while processing the data sequentially. The UABF array weight vector is computed as a weighted average of the array weight vectors across a set of competing beamformers. The competing beamformers each have different values for the regularization parameter. The UABF's weighted average is based on the previous performance of each beamformer. This approach mitigates the risk of poor performance due to mismatch by hedging across the competing models. Remarkably, the UABF is proven to perform asymptotically as well as any of the competing beamformers for each individual sequence of observed data. Simulations and a data set of opportunity from the Philippine Sea experiment demonstrate the effectiveness of the UABF [Work supported by ONR 321US].

## BIOGRAPHY

Dr. John R. Buck is a Chancellor Professor in the Department of Electrical and Computer Engineering at the University of Massachusetts Dartmouth. He has taught at the University of Massachusetts Dartmouth since receiving his Ph.D. from the MIT/WHOI Joint Program in 1996. Professor Buck is a Fellow of the Acoustical Society of America and a Senior Member of the IEEE. His teaching awards include the Manning Prize for Excellence in Teaching from the University of Massachusetts President's Office, the Mac Van Valkenburg Early Career Teaching Award from the IEEE Education Society, the Leo M. Sullivan Teacher of the Year award from the UMass Dartmouth Faculty Federation, and the Goodwin Medal from MIT. Professor Buck is a past recipient of the ONR Young Investigator and NSF CAREER awards, as well as a former Fulbright Senior Fellow to Australia. He has held visiting appointments at WHOI, Sydney University, the Australian Defence Science and Technology Organisation, Brown University, George Mason University, the University of Illinois Urbana-Champaign and the University of Saint Andrews. Professor Buck is the co-author of the Signals and Systems Concept Inventory, in addition to two signal processing textbooks. His research interests include array signal processing, underwater acoustics, marine mammal bioacoustics, and engineering pedagogy.



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