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# THE CHINESE UNIVERSITY OF HONG KONG

Department of Information Engineering

*Seminar*

## Variational Bayesian Inference for Sensing Over Wireless Networks

**By**

**Prof. An Liu**

Zhejiang University, China

**Date : 20 August 2024 (Tuesday)**

**Time : 2:30pm – 3:30pm**

**Venue : Rm 801, Ho Sin Hang Engineering Building, CUHK**

*Abstract*

Future wireless networks are envisioned to provide ubiquitous sensing services, driving a substantial demand for high-accuracy and low-complexity estimation algorithms. Variational Bayesian inference (VBI) provides a powerful tool for modeling complex estimation problems and leveraging prior information, but poses a long-standing challenge on computing intractable posterior distributions. In this talk, we propose two problem formulations that are suitable for different sensing scenarios. In the first formulation, the sensing problem is modeled as a multi-dimensional non-convex parameter estimation. We propose a parallel stochastic particle VBI (PSPVBI) algorithm to solve this challenging problem. Due to innovations like particle approximation, added updates of particle positions, and parallel stochastic successive convex approximation (PSSCA), PSPVBI can flexibly drive particles to fit the posterior distribution with acceptable complexity, yielding high-precision estimates of the target parameters. Furthermore, additional speedup can be achieved by deep-unfolding this algorithm to obtain a learnable PSPVBI (LPSPVBI). In the second formulation, the sensing problem is modeled as a structured compressive sensing with a dynamic grid. The state-of-the-art expectation maximization based compressed sensing (EM-CS) methods have a relatively slow convergence speed and each inner iteration in the E-step involves a high-dimensional matrix inverse in general. To better address this problem, we propose an alternating estimation framework (called AE-SC-VBI) based on a novel subspace constrained VBI (SC-VBI) method, in which the high-dimensional matrix inverse is replaced by a low-dimensional subspace constrained matrix inverse. We further prove the convergence of the SC-VBI to a stationary solution of the Kullback-Leibler divergence minimization problem. Finally, we apply the LPSPVBI and AE-SC-VBI to solve several important sensing problems, including multi-band WiFi sensing and TDD massive MIMO channel extrapolation. Simulations demonstrate that the proposed VBI-based algorithms can achieve a much better tradeoff between complexity per iteration, convergence speed, and performance compared to the state-of-the-art algorithms.

*Biography*

An Liu (Senior Member, IEEE) received the B.S. and Ph.D. degrees in electrical engineering from Peking University, China, in 2004 and 2011, respectively. From 2008 to 2010, he was a Visiting Scholar with the Department of ECEE, University of Colorado at Boulder. He was a Post-Doctoral Research Fellow from 2011 to 2013, a Visiting Assistant Professor in 2014, and a Research Assistant Professor with the Department of ECE, HKUST, from 2015 to 2017. He is currently an Associated Professor with the College of Information Science and Electronic Engineering, Zhejiang University. His research interests include wireless communications, stochastic optimization, compressive sensing, and machine/deep learning for communications. He is serving an Editor for IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS and a member for the Signal Processing for Communications and Networking Technical Committee (SPCOM TC) of IEEE Signal Processing Society. He served as an Editor for IEEE TRANSACTIONS ON SIGNAL PROCESSING and IEEE WIRELESS COMMUNICATIONS LETTERS.

**** ALL ARE WELCOME ****

Host: Prof. ZHANG Yingjun Angela (Tel: 3943-8465, Email: yjzhang@ie.cuhk.edu.hk)

Enquiries: Information Engineering Dept., CUHK (Tel.: 3943-8385)