Assembling Stochastic Quasi-Newton Algorithms Using Gaussian Processes

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Abstract
In this talk I will focus on one of our recent developments where we show how the Gaussian process (GP) can be used to solve stochastic optimization problems. Our main motivation for studying these problems is that they arise when we are estimating unknown parameters in nonlinear state space models using sequential Monte Carlo (SMC). The very nature of this problem is such that we can only access the cost function (in this case the likelihood function) and its derivative via noisy observations, since there are no closed-form expressions available. We start from the fact that many of the existing quasi-Newton algorithms can be formulated as learning algorithms, capable of learning local models of the cost functions. Inspired by this we can start assembling new stochastic quasi-Newton-type algorithms, applicable in situations where we only have access to noisy observations of the cost function and its derivatives. We will show how we can make use of the GP model to learn the Hessian allowing for efficient solution of these stochastic optimization problems. Additional motivation for studying the stochastic optimization problem stems from the fact that it arises in almost all large-scale supervised machine learning problems, not least in deep learning. I will very briefly mention some ongoing work where we have removed the GP representation and scale our ideas to much higher dimensions (both in terms of the size of the dataset and the number of unknown parameters).

Biographical Information
Thomas B. Schön is Professor of the Chair of Automatic Control in the Department of Information Technology at Uppsala University. He received the PhD degree in Automatic Control in Feb. 2006, the MSc degree in Applied Physics and Electrical Engineering in Sep. 2001, the BSc degree in Business Administration and Economics in Jan. 2001, all from Linköping University. He has held visiting positions with the University of Cambridge (UK), the University of Newcastle (Australia) and Universidad Técnica Federico Santa María (Valparaíso, Chile). He is a member of The Royal Society of Sciences at Uppsala. He received the Tage Erlander prize for natural sciences and technology in 2017 and the Arnberg prize in 2016, both awarded by the Royal Swedish Academy of Sciences (KVA). He was awarded the Automatica Best Paper Prize in 2014, and in 2013 he received the best PhD thesis award by The European Association for Signal Processing. He received the best teacher award at the Institute of Technology, Linköping University in 2009.