Neurodynamic Optimization with Its Application for Model Predictive Control

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Abstract - Optimization problems arise in a wide variety of scientific and engineering applications. It is computationally challenging when optimization procedures have to be performed in real time to optimize the performance of dynamical systems. For such applications, classical optimization techniques may not be competent due to the problem dimensionality and stringent requirement on computational time. One very promising approach to dynamic optimization is to apply artificial neural networks. Because of the inherent nature of parallel and distributed information processing in neural networks, the convergence rate of the solution process is not decreasing as the size of the problem increases. Neural networks can be implemented physically in designated hardware such as ASICs where optimization is carried out in a truly parallel and distributed manner. This feature is particularly desirable for dynamic optimization in decentralized decision-making situations arising frequently in control and robotics. In this talk, I will present the historic review and the state of the art of neurodynamic optimization models and selected applications in robotics and control. Specifically, starting from the motivation of neurodynamic optimization, we will review various recurrent neural network models for optimization. Theoretical results about the stability and optimality of the neurodynamic optimization models will be given along with illustrative examples and simulation results. It will be shown that many problems in control systems, such model predictive control, can be readily solved by using the neurodynamic optimization models. Specifically, linear and nonlinear model predictive control based on neurodynamic optimization will be delineated.

Biosketch

Jun Wang is a Professor and the Director of Computational Intelligence Laboratory in the Department of Mechanical and Automation Engineering at the Chinese University of Hong Kong. Prior to this position, he held various academic positions at Dalian University of Technology, Case Western Reserve University, and University of North Dakota. Besides, he also holds a Cheung Kong Chair Professorship in computer science and engineering at Shanghai Jiao Tong University on a part-time basis since 2008. He received a B.S. degree in electrical engineering and an M.S. degree in systems engineering from Dalian University of Technology, Dalian, China. He received his Ph.D. degree in systems engineering from Case Western Reserve University, Cleveland, Ohio, USA. His current research interests include neural networks and their applications. He published over 140 journal papers, 11 book chapters, 8 edited books, and numerous conference papers in the areas. He is an Associate Editor of the *IEEE Transactions on Neural Networks* since 1999 and *IEEE Transactions on Systems, Man, and Cybernetics – Part B* since 2003, a member of the Editorial Advisory Board of the *International Journal of Neural System* since 2006. He also served as an Associate Editor of the *IEEE Transactions on Systems, Man, and Cybernetics – Part C* (2002-2005), a guest editor/co-editor of the special issue of *European Journal of Operational Research* (1996), *International Journal of Neural Systems* (2007), and *Neurocomputing* (2008), He was an organizer of several international conferences such as the General Chair of the 13th International Conference on Neural Information Processing (2006) and the 2008 IEEE World Congress on Computational Intelligence. He served as the President of Asia Pacific Neural Network Assembly in 2006 and as a member of several IEEE technical committees over the years. He is an IEEE Fellow.