Algorithms & Learning Methods for CPS/IoT Communication Scheduling

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Modern large-scale distributed systems such as cyber-physical systems (CPS) and the Internet-of-Things (IoT) often consist of components that communicate/interact over shared networks of limited bandwidth and operate with minimal delay. One way to model these communication constraints is to assume that, at any time instant, only a single packet can be reliably transmitted over the network to its destination. In order to coordinate access to this limited communication resource, it is common to design some form of medium access control (MAC) scheme to optimize performance. First, we consider a centralized scheme and show that the optimal strategy is for the scheduler to transmit the signal with the largest magnitude and then employ minimum-mean-squared estimation. We next take on the design of scheduling policies for CPS/IoT nodes making arbitrarily distributed random observations. It is shown that the scheduler design can be expressed as a difference-of-convex functions optimization problem. Furthermore, our formulation leads naturally to the application of data-driven learning approaches, where the design of scheduling policies can be achieved by using an approximate sub-gradient method to solve an empirical risk minimization problem for unknown environments. Time permitting, a fully decentralized strategy is put forth based on order statistics.

Biography

Urbashi Mitra received the B.S. and the M.S. degrees from the University of California at Berkeley and her Ph.D. from Princeton University. Dr. Mitra is currently the Gordon S. Marshall Professor in Engineering at the University of Southern California. She was the inaugural Editor-in-Chief for the IEEE Transactions on Molecular, Biological and Multi-scale Communications. She has been a member of the IEEE Communication Society's Board of Governors (2018-2020), the IEEE Information Theory Society's Board of Governors (2002-2007, 2012-2017), the IEEE Signal Processing Society's Technical Committee on Signal Processing for Communications and Networks (2012-2016), the IEEE Signal Processing Society's Awards Board (2017-2018), and the Chair/Vice Chair of the IEEE Communications Society, Communication Theory Techcnial Committee(2019-2020,2017-2018). Dr. Mitra is a Fellow of the IEEE. She is the recipient of: the 2017 IEEE Women in Communications Engineering Technical Achievement Award, a 2015 UK Royal Academy of Engineering Distinguished Visiting Professorship, a 2015 US Fulbright Scholar Award, a 2015-2016 UK Leverhulme Trust Visiting Professorship, IEEE Communications Society Distinguished Lecturer, 2012 Globecom Signal Processing for Communications Symposium Best Paper Award, 2012 US National Academy of Engineering Lillian Gilbreth Lectureship, the 2009 DCOSS Applications & Systems Best Paper Award, 2001 Okawa Foundation Award, 2000 Ohio State University's College of Engineering Lumley Award for Research, 1997 Ohio State University's College of Engineering MacQuigg Award for Teaching, and a 1996 National Science Foundation CAREER Award. She has been an Associate Editor for multiple IEEE publications. Dr. Mitra has held visiting appointments at: King's College, London, Imperial College, the Delft University of Technology, Stanford University, Rice University, and the Eurecom Institute. Her research interests are in: wireless communications, communication and sensor networks, biological communication systems, detection and estimation and the interface of communication, sensing and control.