Graphical Model-Based Algorithms for Data Association in Distributed Sensing

Lei Chen, Mujdat Çetin, and Alan S. Willsky
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, MA 02139
phone: 617-253-6172
deadline: lcchen@mit.edu
deadline: mce@mit.edu
deadline: willsky@mit.edu

Abstract  Associating sensor measurements with target tracks is a fundamental and challenging problem in multi-target tracking. The problem is even more challenging in the context of sensor networks, since association is coupled across the network, yet centralized processing is in general infeasible due to power and bandwidth limitations. Hence efficient, distributed solutions are needed. We propose techniques based on graphical models to efficiently solve such data association problems in sensor networks. Our approach takes advantage of the sparsity inherent in the problem structure resulting from the fact that each target can be observed by only a small number of sensors and makes use of efficient message-passing algorithms for graphical models to infer the maximum a posteriori (MAP) association configuration. We illustrate our approach for several typical scenarios in multi-target tracking. Our approach scales well with the number of sensors in the network, and it is well suited for distributed implementation. Distributed inference is realized by a message-passing algorithm which requires iterative, parallel exchange of information among neighboring nodes on the graph. So as to address trade-offs between inference performance and communication costs, we also propose a communication-sensitive form of message-passing that is capable of achieving near-optimal performance using far less communication. We demonstrate the effectiveness of our approach with experiments on simulated data.