Title:
Distributed Least-Squares Classification in Wireless Sensor Networks

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Abstract:
Advances in microelectronics have made possible the deployment of thousands of miniature sensors, each equipped with simple sensing functionality and a wireless interface. Once deployed in an environment (e.g., a city), such wireless sensor networks make local measurements (e.g., the presence or absence of various toxins) that are useful for global decision-making (e.g., in an early warning system for a terror attack). Classical methods for learning or data mining are often infeasible for exploring structure within the sensors' measurements, since tight constraints on energy and bandwidth often limit the sensors' ability to communicate raw data. Thus, wireless sensor networks provide an especially strong motivation for the problem of distributed learning under communication constraints.

In this paper, the problem of binary classification in sensor networks is discussed. After a brief review of the classical supervised learning model, the challenges that wireless sensor networks pose for distributed learning are discussed. Subsequently, a general model for distributed learning is posed, of which distributed least-squares classification is a special-case. Then, a natural class of distributed learning algorithms is shown to be inferior (in a well-defined and provable sense) to a corresponding class of iterative message-passing algorithms. The dynamics of the message-passing algorithms are analyzed using standard techniques, and their utility to wireless sensor networks is validated through several numerical experiments.