

**FINE: A Framework for Distributed Learning on Incomplete Observations for Heterogeneous Crowdsensing Networks**

**Abstract:**

In recent years, there has been a wide range of applications of crowdsensing in mobile social networks and vehicle networks. As centralized learning methods lead to unreliabitlity of data collection, high cost of central server, and concern of privacy, one important problem is how to carry out an accurate distributed learning process to estimate parameters of an unknown model in crowdsensing. Motivated by this, we present the design, analysis, and evaluation of FINE, a distributed learning framework for incomplete-data and nonsmooth estimation. Our design, devoted to develop a feasible framework that efficiently and accurately learns the parameters in crowdsensing networks, well generalizes the previous learning methods in which it supports heterogeneous dimensions of data records observed by different nodes, as well as minimization based on non-smooth error functions. In particular, FINE uses a novel *distributed record completion* algorithm that allows each node to obtain the global consensus by an efficient communication with neighbors, and a *distributed dual average* algorithm that achieves the efficiency of minimizing non-smooth error functions. Our analysis shows that all these algorithms converge, of which the convergence rates are also derived to confirm their efficiency. We evaluate the performance of our framework with experiments on synthetic and real-world networks.

**Existing System:**

First, in real world crowdsensing settings, mobile devices are likely to be located over an enormous space, which makes it both energy consuming and prone to error for central server collecting data from all mobile devices, especially those who are distributed far away from the server. Second, dealing with large volume of data by centralized algorithms requires an expensive highconfiguration data center that possesses huge memory for data storage and processing. Third, managing data by central servers make the private

information of users more likely to be exposed to the adversary, which might cause severe information leakage.

**Proposed System:**

We propose FINE, a novel framework addressing a class of distributed learning problems in heterogeneous crowdsensing networks. FINE is robust to observation noises, capable of handling fragmentary data inputs as well as non-smooth objective functions, and efficient to solve distributed learning problems with a convergence rate2 of *O*( log *√ |V|* 1*−C* ).

We design two important algorithms in FINE: a DRC algorithm to ensure each node to acquire complete information based on its incomplete data acquisition, and a DDA algorithm to solve non-smooth convex optimizations with efficiency.

We formally prove the convergence of the above two algorithms, and further derive their convergence rates. We provide the insights on the relationship between the convergence rate and the network topology, and reveal important design principles for such networks.