

Statistical analysis of stochastic gradient descent

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Abstract: In many applications involving large dataset or online updating, stochastic gradient descent provides a convenient way to compute parameter estimates and has gained increasing popularity due to its numerical convenience and memory efficiency. While the asymptotic properties of SGD-based estimators have been established decades ago, statistical inference such as interval estimation remains much unexplored. The traditional method such as the bootstrap is not computationally feasible since it requires to repeatedly draw independent samples from the entire dataset. The plug-in method is not applicable when there are no explicit formulas for the covariance matrix of the estimator. In this paper, we propose an inferential procedure for stochastic gradient descent. The proposed method is easy to implement in practice. We establish its theoretical properties for a general class of models that includes generalized linear models and quantile regression models as special cases. The finite-sample performance and numerical utility is evaluated by simulation studies and two real data applications