

THE UNIVERSITY



OF HONG KONG

Department of Mathematics

Qualifying Research Seminar

Stability and Generalization of Stochastic Gradient Methods with Bias

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(Supervisor: Professor Yunwen LEI)

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Rm 210, Run Run Shaw Building, HKU

Abstract

Stochastic gradient methods are foundational for large-scale machine learning, with biased variants (e.g., Zeroth-order, Clipped, Decentralized methods) valued for robustness, efficiency, and reduced computational cost. However, existing theoretical research focuses primarily on their convergence, leaving generalization— a core machine learning concern— understudied, especially for minimax problems. Current generalization analyses are limited to specific algorithms and rely on restrictive assumptions (e.g., fast-decaying step sizes), creating critical gaps.

We develop a unified framework for analyzing the stability and generalization of biased stochastic gradient methods, covering both minimization and minimax problems. We apply the framework to Biased-SGD (convex minimization) and Biased-SGDA (convex-concave minimax problems), deriving stability and generalization bounds for specific methods (Zeroth-order SGD/SGDA, Clipped-SGD/SGDA, Decentralized SGD). These results improve existing analyses by removing unrealistic assumptions and achieving minimax optimal excess risk bounds.

All are welcome