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Safe-EF: Error Feedback with Applications to Distributed Safe Reinforcement Learning

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Federated learning faces severe communication bottlenecks due to the high dimensionality of model updates. Communication compression with contractive compressors (e.g., Top-K) is often preferable in practice but can degrade performance without proper handling. Error feedback (EF) mitigates such issues but has been largely restricted to smooth, unconstrained problems, limiting its real-world applicability where non-smooth objectives and safety constraints are critical. We advance our understanding of EF in the canonical non-smooth convex setting by establishing new lower complexity bounds for first-order algorithms with contractive compression. Next, we propose Safe-EF, a novel algorithm that matches our lower bound (up to a constant) while enforcing safety constraints essential for practical applications. Extending our approach to the stochastic setting, we bridge the gap between theory and practical implementation. Extensive experiments in a reinforcement learning setup, simulating distributed humanoid robot training, validate the effectiveness of Safe-EF in ensuring safety and reducing communication complexity.

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