HOMEWORK 8. MIXED-PRECISION TRAINING

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Attention: Turn in your homework at the beginning of our lecture on Dec. 5, 2023

1 SGD with mixed-precision

Consider the stochastic optimization problem:

$$\min_{x \in \mathbb{R}^d} \quad f(x) = \mathbb{E}_{\xi \sim \mathcal{D}}[F(x; \xi)] \tag{1}$$

SGD with mixed-precision training can be approximated by

$$g_k = \nabla F(x_k; \xi_k) \tag{2}$$

$$x_{k+1} = x_k - \gamma Q(g_k) \tag{3}$$

where operator $Q(\cdot)$ quantizes g_k with fewer bits. Assume $f(x)$ is L-smooth, each stochastic gradient $\nabla F(x; \xi)$ is unbiased and has bounded variance σ^2. Furthermore, we make the following assumptions on quantization operator $Q(\cdot)$.

Assumption 1.1. The (probably randomized) quantization operator $Q(\cdot)$ satisfies

$$\mathbb{E}[Q(g)] = g, \quad \forall g \tag{4}$$

$$\mathbb{E}[\|Q(g) - g\|^2] \le \zeta^2, \quad \forall g \tag{5}$$

and the random quantization operator $Q(\cdot)$ is independent of the random sample ξ.

Please prove the convergence rate of algorithm (2)–(3).