Low rank matrix recovery via projected subgradient methods

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Abstract

This work focuses on robust low-rank matrix recovery problems–such as matrix completion, image inpainting, and nonnegative matrix factorization–where nonconvex and nonsmooth structures frequently arise. We approach these tasks using projected subgradient methods and interpret the recovery objectives through the lens of paraconvexity, a broad function class that extends beyond convexity while preserving useful analytical properties. We analyze the convergence behavior of projected subgradient methods under various step-size regimes, including constant, nonsummable, square-summable, geometrically decaying, and Scaled Polyak's rules. Under paraconvexity and a generalized Hölderian error bound condition, we establish convergence guarantees and derive complexity bounds. Numerical experiments across several low-rank recovery tasks confirm the practical effectiveness of our approach and support the theoretical findings.