

ABSTRACT

ONLINE CONVEX OPTIMIZATION USING ADAPTIVE STEP SIZE COORDINATE DESCENT (AS-CD) ALGORITHM

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This research investigates the development and analysis of the Adaptive Step Size Coordinate Descent (AS-CD) algorithm within the framework of online convex optimization. The proposed algorithm integrates an adaptive step size update mechanism based on geometric decay and local gradient information with the Gauss–Southwell coordinate selection strategy, enabling dynamic and well-controlled updates at each iteration. From a theoretical perspective, the fundamental properties of the adaptive step size mechanism are analyzed through a series of lemmas addressing monotonicity, global boundedness, and the characterization of two adaptation regimes. Based on this analysis, the convergence of AS-CD is established for convex and strongly convex functions. In the context of online optimization with time-varying objective functions, a dynamic regret bound is derived, showing that the performance of AS-CD is governed by the variation of the optimal solution trajectory. Numerical evaluations under various static and dynamic scenarios demonstrate that AS-CD exhibits improved iterative stability and a faster decay rate of time-averaged regret compared to methods with a fixed step size on smooth objective functions. However, in scenarios involving abrupt changes in the optimum, fixed step size methods in some cases yield smaller regret constants, highlighting the trade-off between step size adaptivity and the magnitude of the regret constant.

Keywords: *adaptive step size, coordinate descent, Gauss–Southwell rule, online convex optimization, dynamic regret, path variation.*