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Accelerated Proximal Gradient Methods in the affine-quadratic case

Recent works by Bot,-Fadili-Nguyen and by Jang-Ryu address the long-standing question of iterate convergence for accelerated (proximal) gradient methods. Specifically, Bot,-Fadili-Nguyen proved weak convergence of the discrete accelerated gradient descent (AGD) iterates and, crucially, convergence of the accelerated proximal gradient (APG) method in the composite case, in infinite-dimensional Hilbert spaces; their note also documents the announcement timeline. In parallel, Jang-Ryu established point convergence both for the continuous-time accelerated flow and for the discrete AGD method in finite dimensions. These results leave unanswered the question of which minimizer is the limit point. We show in the affine-quadratic setting: starting from the same initial point, the difference between the PGM and APG iterates converges weakly to zero, so APG converges weakly to the best approximation of the starting point in the solution set; moreover, under mild conditions, APG converges strongly. Our results are tight: a two-dimensional example shows that this coincidence of limits is specific to the affine-quadratic regime and does not extend in general.