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Least Squares Estimation of Weakly Convex Functions

Function estimation under shape restrictions, such as convexity, has many practical applications and has drawn a lot of recent interests. In this work we argue that convexity, as a global property, is too strict and prone to outliers. Instead, we propose to use weakly convex functions as a simple alternative to quantify “approximate convexity”—a notion that is perhaps more relevant in practice. We prove that, unlike convex functions, weakly convex functions can exactly interpolate any finite dataset and they are universal approximators. Through regularizing the modulus of convexity, we show that weakly convex functions can be efficiently estimated both statistically and algorithmically, requiring minimal modifications to existing algorithms and theory for estimating convex functions. Our numerical experiments confirm the class of weakly convex functions as another competitive alternative for nonparametric estimation.