Penalized Interaction Estimation for Ultrahigh Dimensional Quadratic Regression

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Abstract: Quadratic regression goes beyond the linear model by simultaneously including main effects and interactions between the covariates. The problem of interaction estimation in high dimensional quadratic regression has received extensive attention in the past decade. In this article we introduce a novel method which allows us to estimate the main effects and interactions separately. Unlike existing methods for ultrahigh dimensional quadratic regressions, our proposal does not require the widely used heredity assumption. In addition, our proposed estimates have explicit formulas and obey the invariance principle at the population level. We estimate the interactions of matrix form under penalized convex loss function. The resulting estimates are shown to be consistent even when the covariate dimension is an exponential order of the sample size. We develop an efficient ADMM algorithm to implement the penalized estimation. This ADMM algorithm fully explores the cheap computational cost of matrix multiplication and is much more efficient than existing penalized methods such as the all-pairs LASSO. We demonstrate the promising performance of our proposal through extensive numerical studies.