Variable Selection for Sparse High-Dimensional Nonlinear Regression Models by Combining Nonnegative Garrote and Sure Independence Screening

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ABSTRACT

In many regression problems, the relations between the covariates and the response may be nonlinear. Motivated by the application of reconstructing a gene regulatory network, we consider a sparse high-dimensional additive model with the additive components being some known nonlinear functions with unknown parameters. To identify the subset of important covariates, we propose a new method for simultaneous variable selection and parameter estimation by iteratively combining a large-scale variable screening (the nonlinear independence screening, NLIS) and a moderate-scale model selection (the nonnegative garrote, NNG) for the nonlinear additive regressions. We have shown that the NLIS procedure possesses the sure screening property and it is able to handle problems with non-polynomial dimensionality; and for finite dimension problems, the NNG for the nonlinear additive regressions has selection consistency for the unimportant covariates and also estimation consistency for the parameter estimates of the important covariates. The proposed method is applied to simulated data and a real data example for identifying gene regulations to illustrate its numerical performance.

Key Words: Gene regulations, independence learning, nonlinear regressions, nonnegative garrote, sigmoid function, sure screening.

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