Boosting Techniques for Nonlinear Time Series Models

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Abstract

Many of the popular nonlinear time series models require *a priori* choice of parametric functions which are assumed to be appropriate in specific situations. This approach is used mainly in financial applications, when there is sufficient knowledge to prespecify the nonlinear structure between the covariates and the response. One principal strategy to investigate a broader class on nonlinear time series is the Nonlinear Additive AutoRegressive (NAAR) model. The NAAR model estimates the lags of a time series as exible functions in order to detect non-monotone relationships between current observations and past values. We consider two modifications of a numerical optimization rather than a "traditional" statistical model, called boosting. The first algorithm considers boosting of additive models, built on top of penalized B-Splines. The second strategy is boosting of linear models. Particularly, the componentwise boosting performs a *built-in* variable selection, as well as a model choice, both of which are facilitated simultaneously. Thus we address the major issues in time series modelling: lag selection and nonlinearity. An extensive simulation study compares the outcomes of boosting to the outcomes, obtained through alternative nonparametric methods. Boosting shows an overall strong performance in terms of precise estimations of highly nonlinear lag functions. The forecasting potential of boosting is examined on real data with target variable the German industrial production (IP). In order to improve the model's forecasting quality we supply it with additional information through exogenous variables. Thus we address the second major aspect in this paper which concerns the issue of high-dimensionality in the models, i.e. models with many covariates. Allowing additional inputs in the model extends the NAAR model to an even broader class of models, namely the NAARX model. We show that boosting can cope with large models which have many covariates compared to the number of observations.

Keywords: componentwise boosting, forecasting, nonlinear times series, autoregressive models, additive models, lag selection.