A new approach to adaptive spline threshold autoregression by using Tikhonov regularization and continuous optimization

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Abstract

This paper investigates the use of conic adaptive spline treshold autoregression (C-ASTAR) which was developed using adaptive spline treshold autoregression (ASTAR) and conic quadratic programming (CQP).

MARS, a modern technology in statistical learning, has importance in regression and classification [1]. MARS is very useful for high dimensional problems and shows a great promise for fitting nonlinear multivariate functions. MARS technique does not impose any particular class of relationship between the predictor variables and outcome variable of interest. In other words, a special advantage of MARS lies in its ability to estimate the contribution of the basis functions so that both the additive and interaction effects of the predictors are allowed to determine the response variable.

By letting the predictor variables in the MARS algorithm be lagged in values of a time series system, one obtains a univariate ASTAR model for nonlinear autoregressive threshold modeling and analysis of time series, thereby extending the threshold autoregression (TAR) time series methodology [2]. ASTAR consists of two complementary algorithms as MARS. To estimate the model function, as MARS algorithm, ASTAR has two stepwise algorithms, which provide to determinate basis functions stand in the model and to get the best appropriate model. Because the model obtained with the forward stepwise algorithm used in the first step has a very complex structure in the second step using backward stepwise algorithm basis functions remove in turn to reach optimum model.

In this study, a new approach was applied for the second stepwise algorithm of ASTAR. With this approach, ASTAR model turned to the Tikhonov regularization problem was transformed to CQP problem. When bounds of this optimization problem are determined using multiobjective optimization approach, too many solutions can be obtained. Thus, it is aimed to attain an optimum solution.

In conclusion, linear regression, ASTAR algorithm and C-ASTAR algorithm were applied to two different time series data sets, and these approaches performances were compared by using different measures.

Keywords

Time series, Multivariate adaptive regression splines (MARS), Adaptive splines treshold autoregression (ASTAR), Tikhonov regularization, Multiobjective optimization, Conic quadratic programming (CQP).

References

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