

OPTIMISATION OF FUZZY TIME SERIES MODELS

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ABSTRACT

The development of time series (TS) forecasting models is one of the scientific bases commonly used to improve decision-making processes, whether operational, tactical or strategic. However, established TS formalisms, such as autoregressive integrated moving average (ARIMA), exponential smoothing (ETS), artificial neural networks (NNAR), and autoregressive conditional heteroskedastic (ARCH), have failed to model forecasting problems when the data are presented as linguistic values (e.g. high, low, small, medium, large). Fuzzy TS models (FTS) have been proposed to solve this limitation. In particular, Abbasov and Mamedova formalism (AM) has performed well in real-world forecasting exercises. AM model has advantages over other FTS models, as it can predict values outside the range of data used in the training phase. However, its performance depends heavily on three parameters: the number of fuzzy sets, an autoregressive parameter, and the constant chosen to convert quantitative values into fuzzy values. To set the values of these parameters can be a difficult task. The use of metaheuristics, such as genetic algorithms (GA) and simulated annealing (SA), is therefore encouraged. The present work promotes optimised FTS models, based on GA (say FTS-GA) and SA (say FTS-SA). Four time series are used to evaluate the performance of FTS-GA and FTS-SA: Azerbaijan Population (POPAZ), Brazilian GDP Variation (PIBBV), General Price Index (IGPOG), and Brazilian GDP per capita (PIBPC). Mean square error (MSE), mean absolute percentage error (MAPE), and normalised root MSE (NRMSE) have been considered as performance measures. For the sake of comparison, established TS formalisms, i.e. ARIMA, ETS, and NNAR, have been taken into account. As a result, FTS-GA and FTS-SA have presented the best performance, with emphases for the former. Furthermore, the FTS-GA and FTS-SA models did not perform worse for any metric. The average processing time (in seconds) of FTS-SA was 100.33 ± 52.73 , i.e. 46% higher than the one of FTS-GA (68.74 ± 52.73). The remaining models (ARIMA, ETS, and NNAR) have consumed less than 1 second, in average. Lastly, as future works, it is proposed to use a more extensive set of time series, the implementation of alternative optimisation algorithms, and the use of alternative neural net models.

KEYWORDS. Stochastic Processes, Abbasov-Mamedova, Metaheuristics.