



## ABSTRACT

### CALENDAR VARIATION TIME SERIES MODELLING WITH ARIMAX ANFIS

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18/435413/SPA/00651

The application of ARIMAX model to some data with calendar variations has been previously studied and shown good forecasting results. The good results from the application of ARIMAX model are then combined with ANFIS soft computing method to provide more accurate forecasting results. The absence of standard rules to determine the optimum ANFIS architecture has led to the use of and application to many different methods. This study aims to construct the procedure for establishing the optimum ANFIS architecture for time series forecasting. The main contribution of this research is obtaining a new ARIMAX ANFIS procedure to establish an optimum ANFIS architecture, including to determine the input variables, the number of clusters, and the rules for time series forecasting of calendar variations.

The ARIMAX ANFIS procedure consists of two stages, which include (i) initial processing of the data using the ARIMAX method to determine the candidates of significant input variables for ANFIS and (ii) forecasting using the optimum ANFIS architecture by first selecting the significant input variables from the candidates obtained at the initial data processing stage and then determining the number of clusters and optimum rules. The effectiveness of ARIMAX ANFIS procedure based on the use of computation time is shown from the calculation of the asymptotic time complexity.

The proposed ARIMAX ANFIS procedure is applied to time series data, which are influenced by calendar variations, by conducting simulation and empirical studies. The simulation study uses two approaches to examine the behavior of the proposed ARIMAX ANFIS architecture to assess the consistency of the ANFIS architecture by comparing the forecasting results for an extended sample size and identifying the stability of the ANFIS architecture by dividing the dataset ratio. The ARIMAX ANFIS procedure is applied in an empirical study of three real data, including data on the Consumer Price Index for the Clothing Category, the number of Passengers at Tanjung Priok port, and the number of Train Passengers



in Non-Jabodetabek area of Java Island, which are affected by variations in the Eid Mubarak (Ied al-Fitr/Idul Fitri) calendar. The proposed ARIMAX ANFIS procedure can provide good accuracy in terms of the small RMSE and MAPE values for all the problems studied. From the results of the simulation and empirical studies, it can be concluded that the use of a minimum number of clusters and rules as well as the inclusion of calendar variation variables always result in a lower error rate compared to the results of forecasting without including the calendar variation variables. This is in line with the results of the asymptotic time complexity of the procedure operation which is directly proportional to the input that consists of the number of observation objects, the number of input variables, and the number of the clusters used.

The proposed ARIMAX ANFIS procedure can be used as an alternative time series data analysis since it can produce good forecasting accuracy. The application of ARIMAX and LM test to determine the optimum ANFIS architecture has proved to be effective and can improve the accuracy of ANFIS predictions. In addition, incorporating strongly relevant exogenous variables into the time series model can improve the forecasting accuracy.

**Keywords:** ARIMAX, ANFIS, timeseries, calendar variation, input variable , cluster, LM test.