

# Intuitionistic Fuzzy Time Series: A Cascade Prediction Model

Ozge CAGCAG YOLCU<sup>1</sup> and Ufuk YOLCU<sup>1</sup>

<sup>1</sup>*Marmara University, Istanbul, Turkey*

## Abstract

Time series prediction models have both theoretical and practical significance in a wide research area such as finance, health care, environment, and energy. The main purpose of time series analysis is to get an accurate picture of the future. Obtaining satisfactory prediction results is only possible with a suitable and competent prediction tool. Prediction tools introduced in the literature can be evaluated under two subtitles as probabilistic and non-probabilistic tools. While the traditional statistical methods constitute probabilistic methods, fuzzy-based systems, and computational-based systems including machine learning, deep learning, etc. methods constitute the non-probabilistic methods. Fuzzy-based prediction models are effectively used as a non-probabilistic prediction tool when the data sets are vague and linguistic terms. Fuzzy-based prediction models firstly proposed by Song and Chissom [2], as based on Zadeh's fuzzy set theory [3], do not take into consideration both the neutrality degree and the non-membership degrees. In order to overcome this issue, intuitionistic fuzzy time series prediction models (IFTS-PM), based on Atanassov's intuitionistic fuzzy sets [1], have been put forward. Although current IFTS-FMs use non-membership values as inputs in the prediction process as well as memberships, they only model linear or non-linear relationships between inputs and outputs. However, simultaneous modeling of linear and non-linear relationships between inputs and outputs, which contain valuable information for time-series prediction, will improve prediction accuracy. In this study, we aim to consider both linear and non-linear intuitionistic fuzzy relationships between inputs and outputs together in an IFTS-PM. For this purpose, a cascade forward neural network is used to get these relations and the model is called as intuitionistic fuzzy time series-cascade prediction model (IFTS-CPM). Cascade forward neural network is also capable of accommodating the nonlinear relationship between input and output by not eliminating the linear relationship between the two. By using the intuitionistic fuzzy C-means clustering algorithm, the membership and non-membership values are obtained for each time-series observation. And these membership and non-membership values are used as inputs of the cascade neural network besides the lagged observations of real time-series. The target values are also composed of real observation of time-series at t time. The performance of IFTS-CPM has been discussed on test sets of some real-world time-series, comparatively via the error criteria, in addition,

the convergence time has been examined, and also the fitting of predicts and observations has been presented with different demonstrations.

## **Keywords**

Intuitionistic fuzzy time series, Cascade forward neural network, Time series prediction, Intuitionistic fuzzy relation.

## **References**

- [1] Atanassov, K.T. (1986). Intuitionistic fuzzy sets. *Fuzzy Sets Systems*, 20(1), 87–96.
- [2] Song, Q. and Chissom, B.S. (1993). Fuzzy time series and its models. *Fuzzy Sets Systems*, 54, 269–277.
- [3] Zadeh, L.A. (1965). Fuzzy sets. *Information and Control*, 8(3), 338–353.