Chapter 3

Intuitionistic Fuzzy Time Series Forecasting Based on Dual Hesitant Fuzzy Set for Stock Market:

DHFS-Based IFTS Model for Stock Market

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ABSTRACT

In this chapter, an application of dual hesitant fuzzy set (DHFS) in intuitionistic fuzzy time series forecasting is proposed to handle fuzziness and non-determinism that occurs due to multiple valid fuzzification method for time series data. Advantages of the proposed DHFS-based time series forecasting method are that it includes characteristics of both intuitionistic and hesitant fuzzy sets to handle the non-determinism and hesitancy corresponding to single membership grade multiple membership grades of an element. In the present study, universe of discourse is partitioned and fuzzified the time series data by two different fuzzification methods (triangular and Gaussian) to construct DHFS. Further, elements of DHFS are aggregated to construct the intuitionistic fuzzy sets. Proposed method is implemented over the share market prizes of SBI at BSE, India and SENSEX of BSE to confirm its out performance over existing time series forecasting methods using RMSE and AFER.

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1. INTRODUCTION

Financial time series forecasting has been an important, challenging and intensive working area for researchers and practitioners. Prediction of stock price volatility which translates to high risk is important for investors to take investment decision for better return. Statistical techniques-based methods such as ARMA, ARIMA, ARCH and generalized ARCH were deployed for financial forecasting, but these methods fail to handle the uncertainty caused by the non-probabilistic and linguistic representation of financial time series data. Fuzzy set (Zadeh, 1965) based time series forecasting model proposed by Song & Chissom (1993, 1994) and Chen (1996) stand out as a key solution for financial instrument forecasting. Researchers and practitioners are more fascinated by fuzzy time series forecasting than traditional time series forecasting method because of their competent ness of handling uncertainty caused by aforesaid reasons. Various researchers (Chen et al., 2012; Hung & Lin, 2013; Wang et al., 2014; Diaz et al., 2016; Rubio et al., 2017) proposed numerous methods based on fuzzy approach for financial time series forecasting. Support vector machine (SVM), neural network, granular computing, genetic algorithm (GA), particle swarm optimization (PSO) and other nature based optimization techniques (Merh, 2012; Huang & Tsai, 2009; Roy, 2015; Lee et al., 2007; Chen & Chen, 2015; Efendi et al., 2015;Askari et al., 2015; Deng et al., 2016; Chen & Phuong, 2017) were integrated with fuzzy approach to propose intelligent fuzzy time series methods for enhancing accuracy in financial time series forecast.

Although fuzzy time series methods achieved great success in financial time series forecasting in environment of non-probabilistic uncertainty, but failed to handle non-determinism. Non-determinism in fuzzy time series forecasting occurs due to hesitation caused by use of single function in fuzzy set for both membership and non-membership and cannot be handled by random probability distribution. Atanassov (1986) generalized fuzzy set and defined Intuitionistic fuzzy set (IFS) to address issue of non- determinism caused by non- stochastic factors. IFS includes two distinct functions to determine membership and non- member ship grade of an element.

Application of IFS in time series forecasting was initiated by Joshi & Kumar (2011, 2012) to include hesitation in financial time series forecasting. Fuzzified IFS (Ansari, 2010) based financial time series forecasting method was proposed by Kumar & Gangwar (2015) to forecast SBI share price. Kumar & Gangwar (2016) defined intuitionistic fuzzy time series and used Cartesian product of IFSs to propose a methodology for intuitionistic fuzzy time series forecasting model. Recently, Wang, et al. (2016) established multidimensional intuitionistic fuzzy modus ponens inference and forecast rules based intuitionistic fuzzy approximate reasoning for time series forecasting. Fan et.al (2016) applied vector quantization and curve similarity measure to define long term intuitionistic fuzzy time series forecasting model to forecast TAIEX.

In real-world problems, it is arduous to define the membership grade of an element due to collection of possible membership values. In decision making problems, it is very general situation when decision maker disagree on the identical membership grade for an element. If fuzzify the time series data using the different fuzzification methods then this situation may also be occur in FTS forecasting. In this situation difficulty of constructing a common membership grade is not because of margin of error or possible distribution values (occurs in IFS or type-2 fuzzy sets, however, due to various possible membership values. To handle these situations, Torra and Narukawa (2009) and Torra (2010) introduced the hesitant fuzzy set (HFS) as a new generalization of fuzzy sets. Qian et al. (2013) introduced the generalized hesitant fuzzy sets and their application in decision support system. Fuzzification of time series data is a crucial step of any fuzzy time series forecasting method and is accomplish by opting the most appropriate