

Chapter 9

Network Based Fusion of Global and Local Information in Time Series Prediction with The Use of Soft-Computing Techniques

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ABSTRACT

Forecasting data from a time series is to make predictions for the future from available data. Thus, such a problem can be viewed as a traditional data mining problem because it is to extract rules for prediction from available data. There are two kinds of forecasting approaches. Most traditional forecasting approaches are based on all available data including the nearest data and far away data with respect to the time. These approaches are referred to as the global prediction scheme in our study. On the other hand, there also exist some prediction approaches that only construct their prediction model based on the most recent data. Such approaches are referred to as the local prediction schemes. Those local prediction approaches seem to have good prediction ability in some cases but due to their local characteristics, they usually fail in general for long term prediction. In this chapter, the authors shall detail those ideas and use several commonly used models, especially those model free estimators, such as neural networks, fuzzy systems, grey systems, etc., to explain their effects. Another issues discussed in the chapter is about multi-step predictions. From the author's study, it can be found that those often-used global prediction schemes can have fair performance in both one-step-ahead predictions and multi-step predictions. On the other hand, good local prediction schemes can have better performance in the one-step-ahead prediction when compared to those global prediction schemes, but usually have awful performance for multi-step predictions. In this chapter, the authors shall introduce several approaches of combining local and global prediction results to improve the prediction performance.

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INTRODUCTION

Time series data can be seen in many application domains, such as daily indices of stock market, various kinds of weather data, and traces of observations of various dynamic processes and scientific experiments. Ways of finding useful information from time series has been investigated for more than a century. In fact, time series can also be viewed as a kind of database. Thus, those techniques considered for finding information from time series can also be considered as data mining techniques. There are some major tasks are considered by the time series data mining community (Keogh, 2008), such as, indexing (Chakrabarti, *et al*, 2002; Meyer, 2005), clustering (Keogh, *et al*, 2006; Keogh & Pazzani, 1998), classification (Keogh & Pazzani, 1998), Motif Discovery (Abe & Yamaguchi, 2005), Prediction (Forecasting) (Su & Huang, 2003), Association Detection (Das, *et al*, 1998), summarization (Indyk *et al*, 2000), Anomaly Detection (Interestingness/Novelty Detection) (Keogh, *et al*, 2002), Segmentation (Keogh & Pazzani, 1998). In this chapter, we would like to report our study on time series prediction.

In recent decades, neural networks, fuzzy systems and neural-fuzzy systems have been successfully applied to many real-world problems, such as system identification, control, prediction, etc. (Rovithakis, *et al*, 1999; Lin, *et al*, 1999; Hwang, 1999; Cabrera & Narendra, 1999; Takashima, 1989; Tanaka & Sano, 1994). These techniques are referred to as model-free estimators because they build models from data without physical knowledge about the system. In the training process, these techniques treat all data equally. Nevertheless, if the prediction is for time series, it is intuitive to say that the most recent data may carry more information than those data far away from the present. Hence, when a prediction model is constructed based on all training data without preference, the resultant prediction may not be accurate enough because the prediction accuracy

may be corrupted by those far away data, which are supposed to have less relationship to the current prediction. Such approaches are referred to as the global prediction schemes in our research.

One may then consider another kind of approach in which the prediction is only based on the most recent data without considering other data. Such a kind of approach in fact is curve-fitting schemes. They are called the local prediction schemes in our research. It is noted that local prediction schemes can also be employed as global prediction schemes by considering all training data as input. However, it is rarely the case, due to its bad performance. As discussed in (Lin, 2000), when it is to predict the value of the next step, good local prediction schemes usually have better performance than global ones do. However, those local prediction schemes only use the most recent information and ignore certain information bearing in the past. Thus, the accuracy of those local prediction schemes may be limited. In (Su, *et al*, 2002), a prediction approach, termed as the Markov Fourier Grey Model (MFGM) is proposed to incorporate global information into local prediction schemes. From those examples shown in (Su, *et al*, 2002), it is evident that MFGM indeed can have the best performances among those existing prediction schemes.

Nevertheless, MFGM is to incorporate global information based on a local prediction scheme, Fourier Grey Model (FGM). As shown later, when the prediction is not one-step ahead prediction, such an approach may have worse performance than traditional global prediction schemes do. Of course, we can simply employ a global prediction scheme to conduct multi-step prediction. But, if we can use both kinds of information, it may have a great chance to obtain a better prediction. In this research, we intend to report our study for fusing global information with local prediction results. Various fusion techniques are introduced and analyzed in this study.

The chapter is organized as follows. After this introduction section, local prediction approaches

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