Chapter 8

A Smart and Dynamic Decision Support System for Nonlinear Environments

S. Uma
Hindusthan Institute of Technology, India

J. Suganthi
Hindusthan College of Engineering and Technology, India

ABSTRACT

The design of a dynamic and efficient decision-making system for real-world systems is an essential but challenging task since they are nonlinear, chaotic, and high dimensional in nature. Hence, a Support Vector Machine (SVM)-based model is proposed to predict the future event of nonlinear time series environments. This model is a non-parametric model that uses the inherent structure of the data for forecasting. The dimensionality of the data is reduced besides controlling noise as the first preprocessing step using the Hybrid Dimensionality Reduction (HDR) and Extended Hybrid Dimensionality Reduction (EHDR) nonlinear time series representation techniques. It is also used for subsequencing the nonlinear time series data. The proposed SVM-based model using EHDR is compared with the models using Symbolic Aggregate approXimation (SAX), HDR, SVM using Kernel Principal Component Analysis (KPCA), and SVM using varying tube size values for historical data on different financial instruments. A comparison of the experimental results of the proposed model with other models taken for the experimentation has proven that the prediction accuracy of the proposed model is outstanding.

INTRODUCTION

Decision making is imperative in all fields of science and engineering. With the advent of high and ultra high frequency observations of massive and complex data sets, the classical paradigms of linear time series is not applicable. Though human beings have developed skills for sensing the context and identifying patterns, modeling and recognizing complex patterns for all contexts is a relatively tough task due to varying human intelligence, memory power, physical abilities and expertise in the field of application. Due to the dynamic and chaotic nature of the nonlinear
time series systems, the traditional decision support systems find more difficulty in extracting meaningful statistics. Hence a booming interest in developing a novel methodology for nonlinear time series analysis to use the retrieved information and assist the decision making process is realized (Fulcher & Jones, 2014).

The design of a time series model requires the modeling of the temporal data (Wu et al., 2005; Grando et al., 2010). The decrease in the cost of storage devices and increase in the performance of computational facilities has motivated the storage of large volumes of data to support the decision making process. Most of this data are time series data which is measured typically at successive times spaced at uniform intervals of time. Since, the time series datasets thus measured are nonlinear, high dimensional and noisy, a dynamic forecasting model that gives importance to the internal structure is required for efficient decision making and analysis. Hence, an intelligent approach towards knowledge extraction from historical database that enables sustainable competitive advantage is essential (Singh, 2007). In nonlinear systems, the changes in the environment are influenced by the previous history of actions or due to external events which is outside the control of the decision maker.

A smart and dynamic decision support system is proposed to overcome the limitations mentioned above for nonlinear environments. The proposed model leverages the advantages of integrating SVM and EHDR representation, thereby providing robust decision support. This research work is aimed at: a) reducing the high dimensionality of nonlinear time series datasets, b) controlling the noise that hinders the analysis and to c) design a smart and dynamic decision support system for nonlinear environments. In this context, the contributions of this chapter are, First the time series representations Hybrid Dimensionality Reduction (HDR) and Extended Hybrid Dimensionality Reduction (EHDR) techniques that reduces the high dimensionality and controls the noise and Second, the SVM based model that uses EHDR for providing a smart and dynamic decision support for nonlinear environments.

Financial Markets are the primary and secondary source of income for a large mass of population. But they are nonlinear, chaotic, noisy and dynamic in nature. The financial instruments like stocks, commodities, futures and options are subject to nonlinear price fluctuations due to the changes in the social, economic, political and climatic conditions. Hence, decision making is a challenging task under such circumstances. To solve the decision making process, historical data and patterns of the past are used. But, historical data are voluminous in nature and remembering the patterns of the past for identifying a solution is a difficult task even for an experienced person adept at technical analysis / reading charts. Hence, the experimentation of the proposed model was done in comparison with \( \varepsilon \) descending Support Vector Regression (SVR), SVR using KPCA, SVM using SAX and SVM using HDR for forecasting the financial markets, a real time application used in our daily life. The experimental results have proved that the performance of the proposed SVM based model using EHDR is outstanding compared with other models taken for experimentation.

The chapter is organized as follows. The literature review of related work and the motivation for using SVM for subsequence clustering are given under the sections titled, “Background” and “Support Vector Machines” respectively. Following these sections, the proposed dimensionality reduction methods and the proposed dynamic decision support model are explained. A discussion of the various models taken for the experimentation and a brief description of the metrics used for the evaluation of these models are given in the subsequent sections. Research findings are discussed under the experimental results section and a conclusion is given.