An Intelligent and Dynamic Decision Support System for Nonlinear Environments

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ABSTRACT

Nonlinear time series systems are high dimensional and chaotic in nature. Since, the design of a dynamic and efficient decision making system is a challenging task, a Support Vector Machine (SVM) based model is proposed to predict the future event of a nonlinear time series environment. This model is a non-parametric model that uses the inherent structure of the data for forecasting. The Hybrid Dimensionality Reduction (HDR) and Extended Hybrid Dimensionality Reduction (EHDR) techniques are proposed to represent the time series data and to reduce the dimensionality and control noise besides subsequencing the 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. The experimental results have proved that the prediction accuracy of the proposed model is better compared with other models taken for the experimentation.

Keywords: Dimensionality Reduction, Dynamic Decision Making, Extended Hybrid Dimensionality Reduction, Hybrid Dimensionality Reduction, Nonlinear Time Series Models

1. INTRODUCTION

Most of the real world environments are nonlinear in nature. Financial forecasting, weather forecasting, electricity power demand forecasting, process monitoring and control, research, medical sciences etc., are certain examples of nonlinear applications used in our daily life. Human beings are adept at sensing the context and identifying patterns. Yet, modeling and recognizing complex patterns for all contexts is a relatively difficult task due to factors like varying human intelligence, memory power, physical abilities and expertise in the field of application. Hence, a decision support system is required for nonlinear environments. Since, nonlinear systems are dynamic and chaotic in nature, a time series model is needed to retrieve meaningful statistics. The information retrieved is used in the research of information and assist the decision making process (Elayeb et al., 2011).

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The design of a time series model requires the modeling of the temporal data (Wu et al., 2005; Grando et al., 2010). 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. Due to the decrease in the cost of storage devices and increase in the performance of computational facilities, large volumes of data are stored to support the decision making process. Most of this data are 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 in nonlinear systems. Hence an intelligent approach towards knowledge extraction from historical database that enables sustainable competitive advantage is essential (Singh, 2007).

To overcome the limitations mentioned, an intelligent and dynamic decision support model is proposed for nonlinear environments. The proposed model takes the advantages of integrating SVM and EHDR, thereby providing robust decision support. The objectives of this research are to: a) reduce high dimensionality, b) control the noise and to c) design an intelligent and dynamic decision support system for nonlinear environments. In this context, the contributions of this paper are, first the time series representations Hybrid Dimensionality Reduction (HDR) and Extended Hybrid Dimensionality Reduction (EHDR) methods that reduces the high dimensionality and controls the noise and second, the SVM based model that uses EHDR for providing an intelligent 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 E 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 paper is organized as follows. Section 2 gives the literature review of related work and Section 3 gives the motivation for using SVM for subsequence clustering. In Section 4, the dimensionality reduction methods are explained. The proposed dynamic decision support model is explained in Section 5 and Section 6 describes the models used for experimentation. A brief description of the metrics used for the evaluation of the models in the experimentation is given in Section 7. Research findings are discussed in Section 8 and conclusion is given in Section 9.

2. LITERATURE REVIEW

Decision support systems are extensively used in computational procedures to forecast the future events, to estimate the parameters of a model, to optimize resource utilization or to describe the random behavior. Though a given time series could be fit in several different types of models, the challenge is in finding a model that will be a perfect fit.

Several methods like autoregressive filters, neural networks, genetic algorithms and fuzzy systems exist for solving time series prediction problems. Autoregressive filters can be computationally efficient for low order models
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