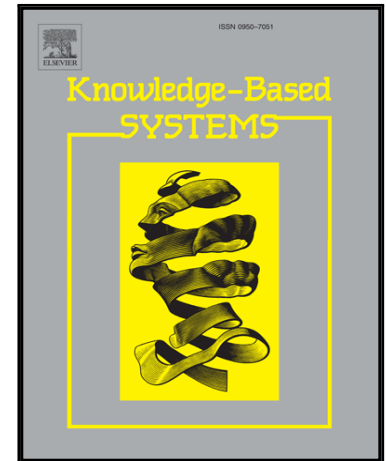


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Red tide time series forecasting by combining ARIMA and deep belief network

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ABSTRACT

The red tide occurs frequently in recent years. The process of the growth, reproduction, extinction of the red tide algal has a complex nonlinear relationship with the environmental factors. The environmental factors have characteristics including time continuity and spatial heterogeneity. These characteristics make it arduous to forecast red tide. This paper mainly analyzes the related factors of the red tide disasters. Based on the strong forecasting ability of Autoregressive Integrated Moving Average (ARIMA) model and the powerful expression ability of Deep Belief Network (DBN) on nonlinear relationships, a hybrid model which combines ARIMA and DBN is proposed for red tide forecasting. The corresponding ARIMA model is built for each environmental factor in different coastal areas to describe the temporal correlation and spatial heterogeneity. The DBN serves to capture the complex nonlinear relationship between the environmental factors and the red tide biomass, and then realizes the warning of red tide in advance. Furthermore, Particle swarm optimization (PSO) is introduced to enhance the speed of model training. Finally, ship monitoring data collected in Zhoushan coastal area and Wenzhou coastal area during 2008-2014 is used as the experimental dataset. The proposed ARIMA-DBN model is applied to forecasting red tide. The experimental results demonstrate that the proposed method achieves a good forecast of red tide.

Keywords: Red tide forecasting; ARIMA; DBN; PSO; ARIMA-DBN

1. Introduction

Red tide is a temporary natural phenomenon involving harmful algal blooms (HABs) in company with a changing sea color from normal to red or reddish brown, which has a bad influence on coast environment and sea ecosystems [1]. The occurrence of red tide is the result of the mixed effects of biological, chemical, hydrological and meteorological factors. These factors lead to the seasonal, spatial heterogeneity and complex nonlinear relationship, bringing great challenge to the prediction of red tide in the field of Marine Science.

Along with the growth of population and the rapid development of economy, the burden of the marine environment is increasing. Red tide has become one of the worst marine disasters effecting on ecological environment, which results from the large amount of untreated waste water directly

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