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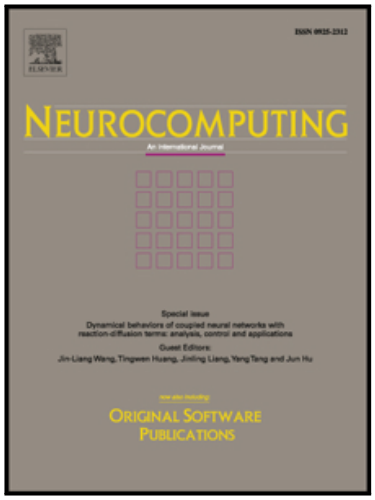

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A Hybrid Time Series Prediction Model Based on Recurrent Neural Network and Double Joint Linear-nonlinear Extreme Learning Network for Prediction of Carbon Efficiency in Iron Ore Sintering Process

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Abstract

Iron ore sintering process is the second-most energy-consuming procedure in the iron making industry. The main energy for it is the combustion of coke, which consists primary of carbon. In order to improve the carbon efficiency, it is necessary to predict it. A comprehensive carbon ratio (CCR) was used to be the metric for estimating the carbon efficiency. An iron ore sintering process has the characteristics of autocorrelation of time series of CCR, multiple variables, linearity and nonlinearity, and time delay. In this study, a hybrid time series prediction model was built to predict the CCR based on these characteristics. It consists of two parts: time series prediction based on Elman recurrent neural network (RNN) and Elman-residuals prediction based on double joint linear-nonlinear extreme learning network (JLNELN). The Elman RNN with a context layer has the ability to model the dynamical and nonlinear components in the time series, and the double JLNELN with the input neurons not only connected to the hidden

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