Time Serial Model of Rock Burst Based on Evolutionary Neural Network

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Abstract. Rock burst is a mining disaster, which can bring large harm. The theory studies have showed that, rock burst is a kind of dynamic phenomenon of mining rock, and is a kind of dynamic disaster from mining. Considering the dynamic character of rock burst, the construction time serial model of rock burst is studied by evolutionary neural network based on immunized evolutionary programming. At last, the proposed model is tested by a real magnitude series of a mine. The result has showed that, evolutionary neural network model not only has high approaching precision, but also has high predicting precision, and is a good method to construct the non-linear model of rock burst.

Keywords: rock burst; mechanics of explosion; dynamic model; evolutionary neural network; time serial.

1 Introduction

In coal mining, at sometimes, the coal or rock will be burst, and a lot of energies will be released. At the same time, the nearby stratum will be produced violence shake, which will be earthquake produced be people. This phenomenon has been called rock burst or coal burst in coal mining branch. From the first rock burst happened in England at 1738, this disaster have been occurred in many coal mine in a lot of countries, such as USA, former U.S.S.R. and Poland, et al. In our country, from the first rock burst happened in Fushun mine at 1933, this disaster have become more and more frequently [1]. So, how to prevent this disaster has become an important work.

For its importance, there have been a lot of studies on rock burst. And many theories have been proposed [2], such as strength theory, stiffness theory, energy theory [3], burst trend theory, catas trophic theory [4], chaotic theory [5], fractal theory [6], et al. Also, a lot of methods to monitor rock burst have been found [7], such as drilled chip measurement, AE technique [8], seismological method [9], electromagnetic emission method [10], et al. We can find that, those theories have only studied the rock burst by mechanical method or mathematic method, and cannot used well in real engineering. While those monitor methods are all only to collect data about rock burst simply and not propose a method to analyze data from theory. So, a utility method to study rock burst is to analyze field data and extract essential model about rock burst.
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For rock burst system is a very complicated dynamic system, its time serial is a very complicated non-linear time serial. To model this kind of time serial, neural network is a very suitable one [11].

The general process of model construction by neural network is as follows.

(1) Supposing the time serial is \( \{x(i), i=1,2, \ldots, n\} \), before model construction, the sample set from the original serial that is applied in training and forecasting process must be constructed. As to forecasting problem, generally the network structure is multi-input and single-output model.

(2) After the above work, the training sets can be formed by sample modes from original serial. If neuron number of input layer is \( p \), the number of the training sets will be \( n-p \). The training sets are as follows,

The first sample is that input values are \( x(1), \ldots, x(p) \) and output value is \( x(p+1) \); The second sample is that input values are \( x(2), \ldots, x(p+1) \) and output value is \( x(p+2) \); \ldots; The sample which order is \( n-p \) is that input values are \( x(n-p), \ldots, x(n-1) \) and output value is \( x(n) \).

In real practice, in order to get the better results, the rolling model method is used, which principles can be showed in Fig. 1. In this method, as a new serial value is produced, this value is added into time serial and the oldest one is displaced. So, the time serial that is used to construct neural network model is all new serial, and then the timeliness effect can be maintained.

![Fig. 1. Principles of rolling model for non-linear time serial forecasting](image)

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To construct a neural network model for rock burst time serial, the construction of neural network is the main problem to be solved. Because for this problem, the hidden layer construction and input layer construction all can be confirmed. This problem can be solved by evolutionary algorithm very well. Here, as a primary study, one new evolutionary neural network which construction is confirmed by evolutionary algorithm and which weight is confirmed by MBP (Modified Back Propagation) algorithm is proposed. To make problem simpler and generalization bigger, the three layers neural network is studied. So, here, only the number of input neuron and number of hidden layer neuron are to be confirmed. In MBP algorithm, there are two parameters, iterating step \( \eta \) and inertia parameter \( \alpha \), to be confirmed. These two