PREDICTION OF THE EARTHQUAKE MOMENT MAGNITUDE BY USE OF THE MULTILAYER PERCEPTRON NEURAL NETWORK

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Theoretical and empirical equations developed for calculating the magnitude of earthquakes are affected by a lot of parameters. Most of these parameters need to be measured and entered in the equations accurately, while, in many areas, due to the lack of required equipment, these parameters mostly are measured approximately and with low precision or even sometimes assumed. Also, some parameters of equations such as physical and functional characteristics of faults are difficult to measure. For example geodetic strain rate of reverse faults with no apparent sign of fault strike on the earth surface, is not measurable. Moreover, these equations usually are exclusive of a specific region or state, so they are not reliable enough for other new regions.

On the other hand, neural networks have been proven to be one of the most practical effects in modelling and forecasting. There are three major advantages of neural networks. First, neural networks are able to learn any complex non-linear mapping. Second, they do not make a priori assumption about the distribution of data. Third, they are very flexible with respect to incomplete, missing and noise data and therefore eliminate concern about this issue (Vellido et al, 1999). Moreover, neural networks, regardless of the region and country, are a general solution in all areas.

Therefore, we believe that the use of neural networks can help us develop a prediction model to identify the level of earthquake moment magnitude.

The aim of this paper is to use a kind of neural network system named Multilayer Perceptron (MLP), which is one of the most influential neural network models, to predict the magnitude of the earthquakes. This method consists of several layers of nodes. It includes an input layer, an output layer, and a hidden layer, each of which contain input node(s), output node(s), and hidden node(s), respectively.

The input nodes are based on some variables. In the current research, six independent variables including three spatial variables (latitude-longitude-depth), one time variable (days), and two variable related to physical characteristics (soil type-fault mechanism) are defined. The output nodes of neural networks are the prediction outputs or labels.

The seismic data that have been used in the research are got from the whole instrumentally recorded earthquakes occurred in Iran.

From whole data, 70% are used for network training and 20% for network testing and revising. The remained 10% is dedicated to derive the final prediction of the magnitudes of earthquakes. Then, these predictions have been compared with exact values to assess the network prediction ability.

In MLP systems it is essential to categorise dependent variable(s) into some branches. So, magnitude of earthquakes is categorized in four groups. These groups are indicated by A, B, C, and D, which represent 4-5, 5-6, 6-7 and bigger than 7 Richter, respectively.

In the hidden layer, as there is no method to decide the optimal number of hidden nodes directly, we choose four different numbers of hidden nodes, including 8, 12, 16 and 20. Moreover, a well-known concern with neural networks is ‘‘overtraining”. To ease this problem, Roiger and Geatz (2003) suggest that the experiments could be continually conducted by different parameters. Therefore, we use a set of four different learning epochs, including 1, 2, 4 and 8. Moreover, in training part, two different training criteria, named Batch and Online, were applicable. In order to reach to more comprehensive results, both of these criteria are applied. As a result, we setup 32 different groups of parameters and shape 32 models accordingly shown in Table 1.

Table 1. Parameters settings of MLP neural networks

32 Models		Number Of Units			
Training Criteria	Epochs	8	12	16	20
Batch	1	N081	N121	N161	N201
	2	N082	N122	N162	N202
	4	N084	N124	N164	N204
	8	N088	N128	N168	N208
Online	1	N081	N121	N161	N201
	2	N082	N122	N162	N202
	4	N084	N124	N164	N204
	8	N088	N128	N168	N208

After all, the results of the study indicate that MLP network has a good capability for predicting the magnitude of earthquakes. As can be seen in Figure 1, the average correct prediction of the models is about 70%. The best prediction is the prediction done by the model N161 using online criteria. Also, the results clarify that both criteria are able of predicting with almost the same precision.

To conclude, according to the results, the network is a functional device in predicting the magnitude of the earthquake of a region in an arbitrarily considered time.

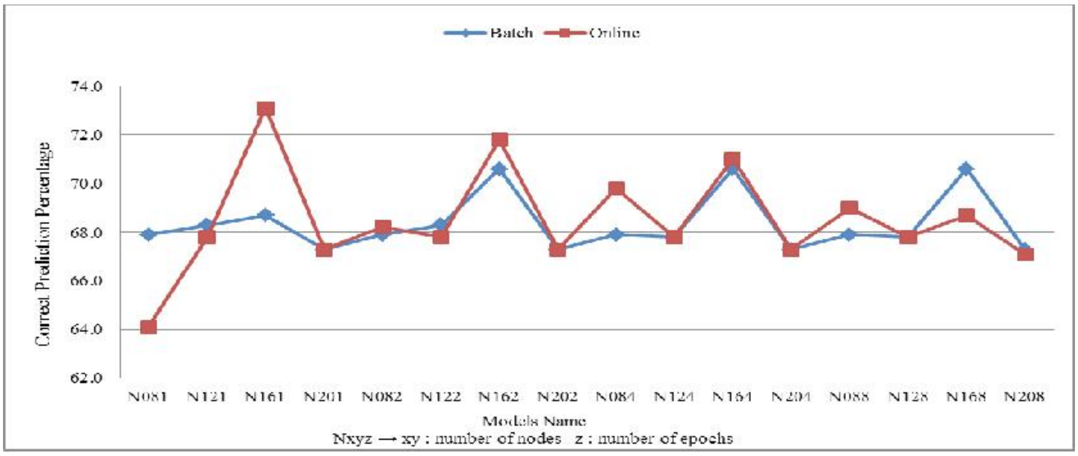

Figure 1. Models correct prediction percentage

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