Earthquake Prediction Based on the Pattern of Points Seismic Motion

Jhon Veri,
Faculty of Computer Science and IT
University of Malaya
Kuala Lumpur, Malaysia
jhon080771@yahoo.co.id

Teh Ying Wah
Faculty of Computer Science and IT
University of Malaya
Kuala Lumpur, Malaysia
tehyw@um.edu.my

Abstract-**The earthquake is an issue that needs attention, and therefore need to explain the shift of tectonic plates that cause earthquakes primary or more commonly known as tectonic earthquakes. While the earth is still spinning, the earth's tectonic plates and crust will also continue to move. So the researchers attempted to locate and identify the movement patterns of the data points by the method of earthquake Back-Propagation Neural Network, by train and to study and analyze seismic data movement pattern of points at the past and try to find a formula or function that will link the data pattern then the desired output. Locations to determine where an earthquake will occur trend by using a set date, time and position of the earthquake. In the end of the validation test used by the earthquake events that occurred in Indonesia.**

***Keywords** : Earthquake Prediction, Pattern of Points Seismic Motion, Back-Propagation Neural Networks*

I. INTRODUCTION

A. Causes of earthquake

The uppermost layer of the earth, namely lithosphere, a relatively cold rocks and the top is in solid condition and rigid. Beneath this layer there is a much hotter rock called the mantle. This layer is so hot, so always in a state of rigid, so it can move with the heat distribution process known as convection flow. Tectonic plates that are part of lithosphere solid and floating on the mantle part ovens with each other. There are three possible movement of one tectonic plate relative to the other, i.e. when the two plates away from each other (spreading), approach each other (collision), and each slide (transform).

If the two plates meet at a fault, they can move away from each other, or mutually shifted toward each other. Generally, these movements are slow and can not be felt by humans, but measured at 0-15cm per year. Sometimes, the plate is jammed and interlocked, resulting in the collection of energy continues until at some point in the tectonic plate rock is no longer able to resist the movement, causing a sudden release of which we know as earthquakes [1,2].

B. Earth Plate Movement in Indonesia.

The latest theory explains that tectonic earthquakes originate from the 1960s decade. According to this theory, the earth's crust consists of 14 major tectonic plates and dozens of small plates are always moving. Why always on the move? Because of the earth is a liquid concentrated form. Fluids are always flowing, even though the average movement is only a few centimeters per year.

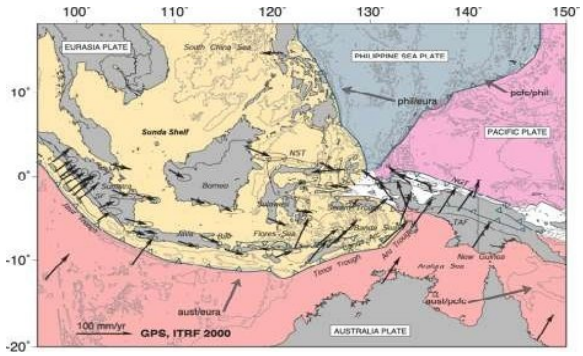

Fig. 1. Plate movement of the Earth in the Indonesian Archipelago

Because of the uneven shape of plate, friction often occurs in this movement. Energy caused by friction is largely separated in the form of heat into the earth, and a few that felt by us as a shock or energy known as seismic (earthquake). In addition to friction plate occurs, cracks can also occur within the plate itself [1].

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II.ARTIFICIAL NEURAL NETWORKS

A. Application of Artificial Neural Networks

Neural network has been trained to perform complex functions in various fields of application that includes the best pattern recognition, identification, voice processing, and control systems. Nowadays artificial neural networks have been used to solve difficult problems for humans or conventional computers. Algorithms that were previously done with a long time and are not accurate when it was not a difficult thing again. Some applications of artificial neural networks are as follows[3,4,5,6,7,8].

a. Pattern Recognition, where the neural network can be used to recognize patterns (eg. letters, numbers, voice or signature) that has been slightly changed.

b. Signal Processing, artificial neural networks that can be used to suppress noise in telephone lines.

c. Predicting, artificial neural networks that can be used to predict what will happen in the future based on the existing pattern of events in the past.

B. Principles of Back-Propagation Neural Network

Back-Propagation Neural Network has some units that exist in one or more hidden screen, v_{ji} a line weight of the input unit x_i to the display unit hidden z_j (v_{j0} is the weight connecting the refraction line in the input unit to hidden display unit z_j). w_{kj} is the weight of the display unit hidden z_j and unit output y_k (w_{k0} is the weight of refraction on the screen is hidden to the output unit z_k) [9,10,11,12].

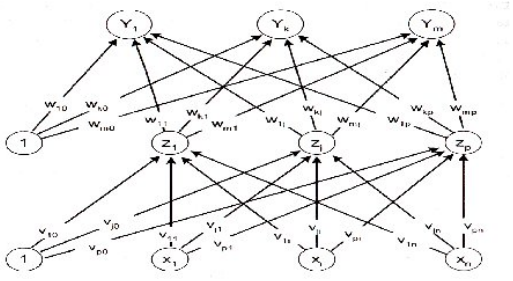

Fig.2. Architecture Back-Propagation NN

Activation function used in Back-Propagation:

1. Binary sigmoid function

$$f(x)=\frac{1}{1+e^{-x}} \quad \text{Rule} \quad f'(x)=f(x)(1-f(x))$$

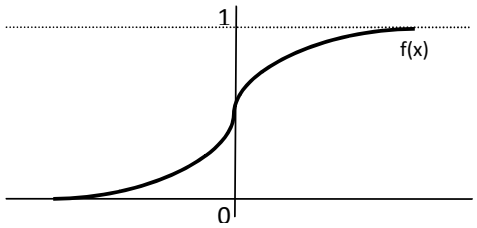

Fig.3. Activation Binary Sigmoid

2. Bipolar sigmoid function

$$f(x)=\frac{2}{1+e^{-x}}-1 \quad \text{Rule} \quad f'(x)=\frac{(1+f(x))(1-f(x))}{2}$$

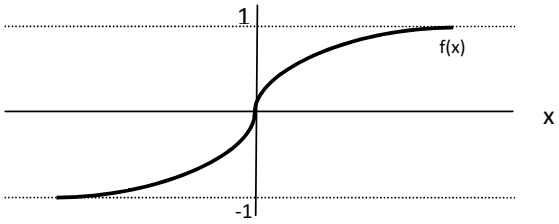

Fig.4. Activation Bipolar Sigmoid

3. Linear function

$$f(x) = x$$

III. EXPERIMENTAL RESULT

Existing data will be grouped into sections or groups. The data already collected will be analyzed, so that in the determination of input and output patterns will be more obvious. Since the data in Indonesia earthquake enough, then the data will be used in the design of artificial neural networks to determine the earthquake prediction based on the trend of movement patterns point earthquake in Indonesia will be divided into 2 (two) parts. The first section is used to train the neural network and the second is used to examine the workings of the neural network.

Table.1.Genesis Data Earthquake in Indonesia 2011

No.	Date	Time	Position(Km)	Area
1.	01/02/2011	14:29:22	6	North Maluku
2.	01/02/2011	22:19:29	157	Bengkulu
3.	01/03/2011	02:11:36	50	North Maluku
4.	01/04/2011	09:36:37	98	Papua
5.	01/05/2011	17:15:38	15	West Sumatera
6.	01/06/2011	09:26:06	14	North Sumatera
7.	01/06/2011	10:01:36	122	North Maluku
8.	01/08/2011	15:15:13	9	Central Sulawesi
9.	01/08/2011	21:41:20	71	West Sumatera
10.	01/10/2011	15:35:35	39	Gorontalo
11.	……	----------	-----	----------

This paper to determine the movement patterns of earthquakes in Indonesia, data used there are only 3 (three) input, namely the date(X_1), time(X_2) and position(X_3).

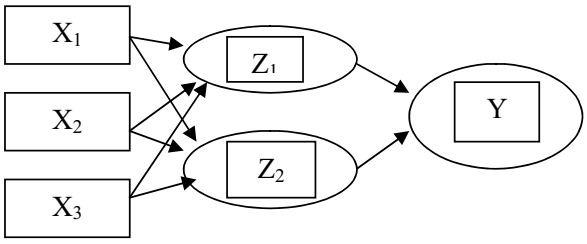

Fig.5.Architecture Back-Propagation NN

Further data on the table.1. is transformed and then The results of the experiment or training Back-Propagation Neural Network trained properly will give a reasonable output if given the same inputs (not necessarily equal) to the pattern used in training. Back-Propagation Neural Network generalization properties which makes training more efficient because it does not need to be performed on all data.

From the results of iteration p = 1 there is still a value that is below 0 (zero), this suggests that the prediction of the expected poor or inappropriate (not accurate). To achieve the correct output value and accurate, it is necessary to do some comparisons of other network architectures and can not be done manually but will have to be assisted by using Matlab software version 6.1. With the results of processing and system design that uses a neural network with Back-Propagation method, it can be concluded that neural networks can be used to determine the movement patterns of point earthquakes that occurred in Indonesia. This can be demonstrated by looking at the output layer (Y value).

The value of the output layer (Y) of the training results are = 0.408541, and this figure shows that the error (e) between the target with the output layer is = -0.438147. While connected with research on the movement of point earthquakes, it was concluded that the pattern is still not accurate or point earthquake that will occur in the future. Accurate value to determine the movement patterns of earthquake point is that if the error value (e) generated is 0 (zero). To generate the error value (e) is smaller, it is necessary to continue training with the weights entering a new beginning, until the resulting error value (e) equal to 0 (zero).

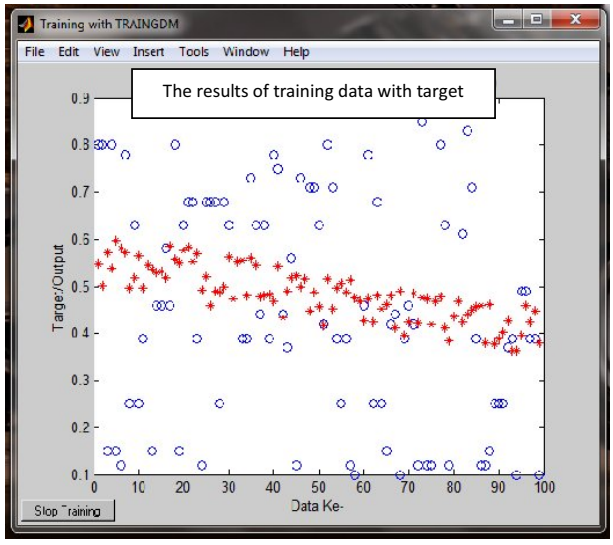

Fig.6.Training Data

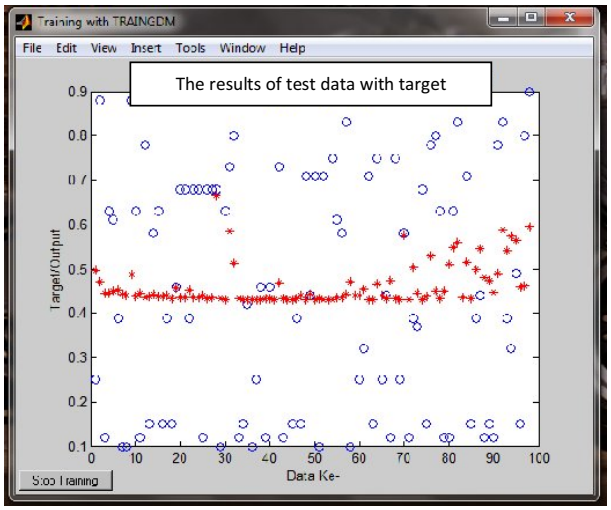

Fig.7. Test Data

From the training data was stopped at the epochs to 100 (default) although the actual desired value (MSE = 0) has not been achieved. At these epochs to 100, the value of the resulting MSE is 938365 with 0.0001 goal. But the test data the value of the resulting MSE is 0.945044 with a goal 0.1.

IV.CONCLUSIONS

Back-Propagation Neural Network method with an architectural pattern 3-2-1. The output value is selected to determine or predict likelihood of the next earthquake is the error value (e) equal to zero i.e. Bengkulu, South Sulawesi, Yogyakarta and accurate a result of training or testing of the output value in determining pattern of point seismic motion.

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