Prediction of Euro 50 Using Back Propagation Neural Network (BPNN) and Genetic Algorithm (GA)

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Abstract— *Modeling time series is often associated with the process forecasts certain characteristics in the next period. One of the methods forecasts that developed nowadays is using artificial neural network or more popularly known as a neural network. Use neural network in forecasts time series can be a good solution, but the problem is network architecture and the training method in the right direction. One of the choices that might be using a genetic algorithm. A genetic algorithm is a search algorithm stochastic resonance based on how it works by the mechanisms of natural selection and genetic variation that aims to find a solution to a problem. This algorithm can be used as teaching methods in train models are sent back propagation neural network. The application genetic algorithm and neural network for divination time series aim to get the weight optimum. From the training and testing on the data index share price euro 50 obtained by the RMSE testing 27.8744 and 39.2852 RMSE training. The weight or parameters that produced by has reached an optimum level in second-generation 1000 with the best fitness and the average 0.027771 the fitness of 0.0027847.Model is good to be used to give a prediction that is quite accurate information that is shown by the close target with the output.*

Keywords— Genetic Algorithm, Back Propagation Neural Network, Euro 50, Prediction, Neural Network.

I. INTRODUCTION

Business activities and the economy, and the prediction to a more accurate next is needed. In the field of economy share price trading day-to-day, both in the form fluctuation gains as well as experienced and to share price that fluctuates allow the corporate investors in the advantages and disadvantages suffered modeling time series is often associated with the inaccurate forecasting certain characteristics in the next period. Divination is suspected or bets that a state in the future based on the past condition and now that is needed to determine when an incident will happen, so that appropriate action can be done That were faced by the buyback inaccurate to data it is data that has changed with. This was in the case data financial and financial fluctuations have a very large and did not remain. In addition, the method conventional forecasts that are used in doing forecasts, the method inaccurate using Neural Network model (NN) can be used as an alternative in divination. NN are able to identify the pattern of a data input by using the method of learning to be trained to learn more about the pattern data the past and try to look for a function that connects the pattern data the past to the exodus was wanted at this time. Forecasts as a mean to resolve the problems economy very important especially in predicting these things that happened in the future so that the application in NN forecast economic data, of course, is very helpful in solving economic problems.

Use NN in forecasts time series can be a solution that good, but the problem is network architecture and the presidential election training method in the right direction. One of the choices that might is to use a Genetic algorithm (GA). GA is suitable to solve the problem combinatorial that require time computing for a long time. Scientists have two different perspectives about AI. The first believes that AI as part of that only a focus on the process to think. While the second believes that AI as knowledge that focuses on their way in demand. This point to two see AI wider because of an appearance must be preceded by a process to think. That is the most suitable AI Definition for the moment is acting rationally with the approach rational agent. This was based on a thought that computer can make a logical reasoning and can also do the action in a rational reasoning based on the result was. A major impediment to scientific progress in many fields is the inability to make sense of the huge amounts of data that have been collected via experiment or computer simulation. In the fields of statistics and machine learning there have been major efforts to develop automatic methods for finding significant and interesting patterns in complex data, and for forecasting the future from such data. In general, however, the success of such efforts has been limited, and the automatic analysis of complex data analysis and prediction can often be formulated as search problems.

II. GENETIC ALGORITHM

a. Definitions Genetic Algorithm

A genetic algorithm has been for the most part techniques applied by computer scientist and engineers to solve practical problems. Genetic algorithm (GA) is a variant of stochastic beam search in which successor states are generated by combining two parent states rather than by modifying a single state. Genetic algorithm (GA) is a search algorithm that based on natural selection mechanism and genetic engineering. A genetic algorithm is one of the algorithms that was very appropriate used to resolve the optimization complex that it is difficult to be done by the methods conventional. GA was first introduced by John Holland at the end of 1975. Every problem which has the shape of adaptation (natural or artificial) can be formulated into the genetic terminology. According to Suyanto (2005) benefits use GA is very obvious from the convenience of implementation and its ability to find a solution that good and can be accepted for the problems dimensions. GA is very useful and efficient to problems with the characteristics as follows:

1. The problem is very big, complex and difficult to understand.
2. Less or no knowledge of the adequate to represent a problem in the search for them that is narrower.
3. Unavailability mathematical analysis that is not adequate.
4. The conventional method is not able to solve the problem faced by.
5. Do not expect a most optimal solution, but enough to approach.
6. There is limitations time, for example, in the real-time system or system real-time.

GA has many applied for the various problem-solving Optimization, among another programming Automatically, the Model, Economic Model Immunization System, the Model Ecological and Machine Learning is designing a neural network to make the process of symbolic production systems. Genetic algorithm (GA) works out of a population which is a solution association that produced by randomly. Each member of the association that represents a solution is named individuals or chromosomes. A chromosome gene, which contains a number coding information that will be stored in chromosomes. A chromosome breed through various repeatedly and each iteration that the so-called generation. In each generation, chromosome chromosomes that produced will be evaluated using a measurement called fitness. To produce a new generation will be done screening based on the fitness to determine chromosomes parents which will produce chromosomes that were formed by combining two chromosomes parents who were chosen to use an operator from marrying a crossroads (crossover) and modify a chromosome use an operator mutations. After going through several generations, this algorithm will convergence to chromosomes best.

b. Coding Scheme

The procedure is a number of individuals to raise randomly or through certain procedures as the population. Population Size depends on the problems that will be broken and types of the genetic operator that will be implemented. After population size is determined steps to initialize chromosome that was found in the population. The chromosomes will be done at random, but it must remain based solutions and domain Bad problems Coding is a technique for states beginning population as a candidate for solutions to a problem to a chromosome as a key issue when using the Genetic algorithm. These genes that are initialized in the genetic algorithm is the first estimates that contained the information in the form the code. A single gene represents a parameter that will be estimated value is so that a function optimally. Suyanto (2005) stated that there is three scheme which is most commonly used in coding,

Property 1: Real-number encoding. In this scheme, the gene is located at a specified interval [0.R].

$$x = r_b + (r_a - r_b)g \quad (1)$$

Property 2: Discrete decimal encoding. In this scheme, the gene is could be high one of the numbers in the interval [0, 9).

$$x = r_b + (r_a - r_b)(g_1 \times 10^{-1} + g_2 \times 10^{-2} + \cdots + g_n \times 10^{-n}) \quad (2)$$

Property 3: Binary encoding. In this scheme, the gene is located 0 or 1

$$x = r_b + (r_a - r_b)(g_1 \times 2^{-1} + g_2 \times 2^{-2} + \cdots + g_n \times 2^{-n}) \quad (3)$$

Assumption 1: System (2 and 3) out of interval

Discrete decimal encoding formula

$$x = r_b + \left(\frac{(r_a - r_b)}{\sum_{i=1}^{n} 10^{-i}}\right)(g_1 \times 10^{-1} + g_2 \times 10^{-2} + \cdots + g_n \times 10^{-n}) \quad (4)$$

Binary encoding

$$x = r_b + \left(\frac{(r_a - r_b)}{\sum_{i=1}^{n} 2^{-i}}\right)(g_1 \times 2^{-1} + g_2 \times 2^{-2} + \cdots + g_n \times 2^{-n}) \quad (5)$$

c. Linear Fitness Ranking (LFR)

For a function, *h who* have small variance, all of the individuals will have more value *fitness* that is almost the same. This resulted in the selection process that bad choice parents on a proportionate basis according to the *fitness*. So, it was required a mechanism called *Linear Fitness Ranks* (LFR). This mechanism aimed to scaling values *fitness*. *Fitness centers* are given highest individual high-value *fitness* (*N* number of individuals in the

population). Individual high- *fitness* second highest level will be given the *fitness* $N-1$ and so on individual high-low fitness was given the *fitness* 1. For example $R(i)$ states ranked individuals to-, $iR(i)=1$ if i is individual high-*fitness* and highest level $R(i)=N$ if i is individual high-low fitness, then the value *fitness* is new is:

$$f(i)=(N+1-R(i)) \quad (6)$$

The *fitness* on the common usage (6) can be very evolution will reach optimum locally because of the little difference between the values *fitness centers* in all of the individuals in the population. The tendency to convergence in local optimum can be reduced by using equation:

$$f(i)=f_{max}-(f_{max}-f_{min})\left(\frac{R(i)-1}{N-1}\right) \quad (7)$$

Thus, the *fitness* that is in interval [$f_{\text{sun}}, f_{\text{max}}$]

d. Selection

Individuals who are in a population, need to be selected individuals are best that can perform a marriage to produce a new individual. The selection was aimed to provide an opportunity reproductive health is higher than for the members population that most Each fit. individuals in the population will receive probability reproductive health is equivalent to the fitness.

e. Operator Genetics

Genetic algorithm (AG) that is a process *heuristic* (increase probability to solve a number of problems) and random so that the emphasis on the election operator that is to determine the success AG in finding solutions fit into a problem that is given. The thing that must be paid attention is to avoid a convergence, in the sense that premature solution that was received by local throughput is the result .There is two operator genetics, namely:

Property 4: After chosen individuals in the selection process, in these individuals will be marriage cross or *crossover*. *The crossover was* aimed at adding on biodiversity string in a population with crossing between a string that is taken from reproductive health. The crossover was done on each individual with probability crossover (p_c) is defined by random in that range (No. 0, 1]. This means that crossover a disagreement can be done only if numbers random that raised less than what p_c is determined. In general p_c stated close to 1.

Property 5: Mutation is processed to change the value of one or several genes in a chromosome. Operation *crossover* that will be done in the chromosome with the aim to find new chromosome as candidate solutions to future generations with *fitness* climate eventually will go to the optimum solution was wanted. If the election process chromosomes that are likely to continue to have a *fitness* that was only, convergence premature infants will be very easy to happen. In other words, the process quest to find solutions that unite trapped in one part of the search so that he would not be able to explore the other chromosome with *fitness* the continued to exist to avoid a convergence prematurely and still keep difference chromosome in the population will be used operator mutations. Procedure mutation is very simple. For all of the genes that is, if the random raised less than probability mutations that p_m determined the changed gene was contrary to the value (in binary encoding, 0 changed 1 and 1 changed 0). It is usually p_m stated as 1/n, with n is the number of genes in the chromosome. The p_m sebking esar this means mutations can only occur in approximately one gene. In AG simple, the value is p_m still during Evolutionists who came could never explain.

f. The Replacement Population

In AG knew population replacement scheme called *generational replacement*, which means all individual (e.g., N individuals in a population) from a generation was replaced as well as by N individual new cross-marriage and the mutations. The scheme replacement is not realistic from the perspective of a biology. In the real world, the individuals from a different generation could be at the same time. Other facts are individuals appear, disappear constantly, not in a generation. In general population replacement scheme can be formulated based on a size that is called *generational gap* G. This shows the percentage population, which was replaced in each generation. In the scheme *generational replacement*, G = 1.

III. BACK PROPAGATION NEURAL NETWORK

Neural Network (NN) is processing information system that has characteristics similar to the network of nerves biology NN is a machine that is designed to work are a modeling human brain in doing function or specific tasks. This Machine has the ability to keep knowledge based on the experience and make your knowledge to be useful. Kusumadewi (2003) explained that in processing information, human brain consists of several neurons that do the job is simple. Neurons in the human brain are connected to each other, then the brain can perform the function processing quite complex. Information processing in man is adaptive, which means that relations between neurons happens dynamically and always have the ability to learn information which has not yet known.

Theory 1

NN is a processing technique computer-based information that analyzes and nervous system are modeling biological.

Theory 2

A mathematical model that contain a large number processing elements that organized in the layers.

Theory 3

A system that computing several elements are made from a simple and processing is interconnected each other for processing information through input from the outside and to be able to respond to the dynamic.

Theory 4

NN is a technology that computing based only on the model biological nerve and trying to simulate appearance and model nerves to various inputs.

Theory 5

Some sense Of the could be concluded that simple NN is a technical computing information processing in the process imitate the mechanism human brain that the mathematical models will be served in the form to settle on various issues.

The characteristics of NN according to Warsito (2009) among others:

1. Have the capacity to produce output to the pattern that has never been studied (*generalization:*).
2. Have the capacity to process input that there is something wrong in it with a certain tolerance level.
3. To Be Able to adapt to changes that happened to the input and output. From this adaptation is manifested in the change of the weight.

In a broad outline in NN have two stages processing information, such as:

Training Phase: This stage began to include the patterns learn (data trained) into the network. By using the pattern of this pattern, the network will change to change its weight to link between nodes. In an each iteration did an evaluation of output network. This step was held in several and each iteration and stopped after the weighted network found that in accordance with the error that is desired has been achieved or the number of an each iteration has reached the maximum set. Weight Advanced to this (basic knowledge at the introduction.

Testing Phase : This step test is done to a pattern input that has never been training before data test result by using the weight stage training It is hoped that the weight of the weight. The training has been an *error* at least will also give *error* testing phase in a small

Network for multi*layer* consists of layers input, the layer is hidden and layer output. A layer secret lies in the input and output levels. The output from a layer secret will be inputs for the next. This Network at least one layer is hidden. Architecture from network for multilayer is described as follows:

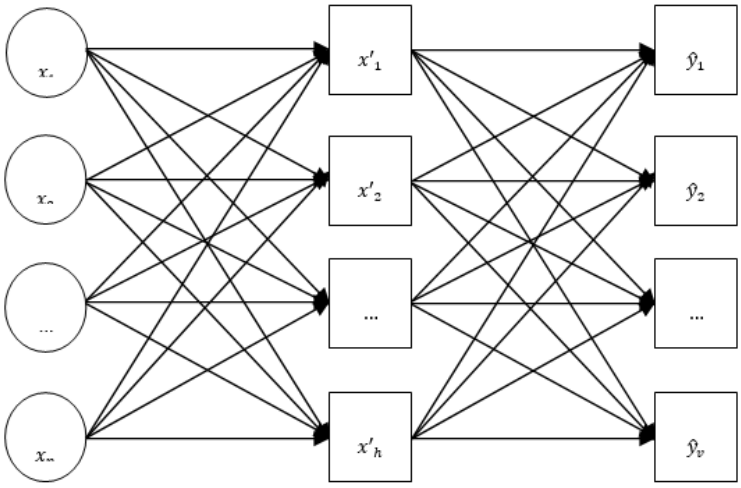

Fig.1: Network for Multilayer

In modeling BPNN for time series, input data model is the past (X_{t-1}, X_{t-2}, ... , X_{t-p}) and target is the present X_t

BPNN is rendered in the equation below:

$$X_t = \psi_o\{ w_{bo} + \sum_{j=1}^{H} w_{jo}\ \psi_j\ (w_{bj} + \sum_{i=1}^{p} w_{ij}\ X_{t-i})\}$$

(8)

ψ_o : A function activating that used in the upper layers output

ψ_j : A function activating that used in the upper layers are hidden

w_{ij} : Neurons weight to-i in the upper layers input toward neurons to-j in the secret

w_{bj} : Weight bias in the upper layers input toward neurons to-j in the secret

w_{jo} : Neurons weight to-j in the secret to layer output

w_{bo} :Weight bias in the upper layers are hidden toward layer output

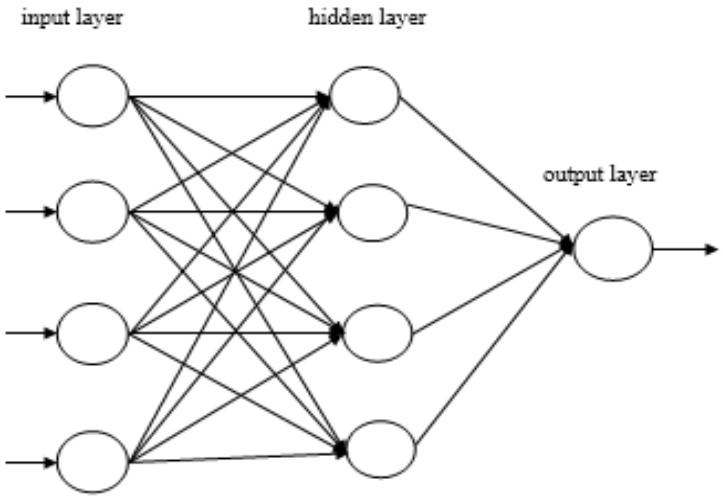

Fig. 2: Illustration Back Propagation Neural Network (BPNN)

Training method network is a process or training procedures network that are the sequence to the integrated algorithm to modify the values and weight bias with the purpose to make a network get the values and weight bias, according to allow it to produce output network that is desired. If a mistake in the output network is very small, it can be said, it has been the values and weight bias and the network has reached good performance. In this training, the size performance a network obtained by counting RMSE (*Root Mean Square error)* between output and target network. If it $\hat{y}_1, \hat{y}_2, \dots, \hat{y}_v$ is output network and $y_1, y_2, \dots, y_v$ is the target for network, so the RMSE can be counted as the formula as follows:

$$RMSE = \sqrt{\frac{1}{v}\sum_{i=1}^{v}(y_i - \hat{y}_i)^2}$$

(9)

Warsito (2009) explained that before training of nerve network model, it is often necessary scaling in input and target that data in a certain range. This is meant to prevent the data is processed in accordance with the function activating that is used. This process is called Pre-Processing. Then after the training is completed, data returned to his original form (Post-Processing). In writing tasks end this function activating that used in hidden layer toward output layer is sigmoid binary (sigmoid logistic), then data should first transform into the interval [0, 1]. However, will be better if the data transformed into a smaller interval, for example at a specified interval [0.1, 0.9]. Remember that This function sigmoid asymptotic is a function which values are not been reached 0 or 1 (Siang, 2005).

*Pre-Processing Phase to t*ransform data into the interval [0.1, 0.9) is as follows:

$$x' = \frac{0.8\,(x-a)}{b-a} + 0.1$$

(10)

Post-Processing phase to return to his original form is as follows:

$$X = \frac{(x' - 0.1)(b-a)}{0.8} + a$$

(11)

Where a is minimum data and b is maximum data.

IV. METHODOLOGY AND SIMULATION

Index data daily Euro 50 period January 2, 2013, up to December 19, 2014, where there is 501 indexes that noted. Some data preprocessing steps on raw set as shown below:

1. Firstly, 80% data were used to training
2. Secondly, a share index data were normalized by min-max normalization into a specified range 0.0 to 1.0

The following are results of training and testing with AG to some measure the tournament "k" and "p_c. Size of population set of 60 chromosomes and the mutations with probability mutations (p_m) = 0.01.Once they reach 1000 generation by mse training=776.9827, rmse training =27.8744, mse testing = 1543.3 and rmse testing=39.2852

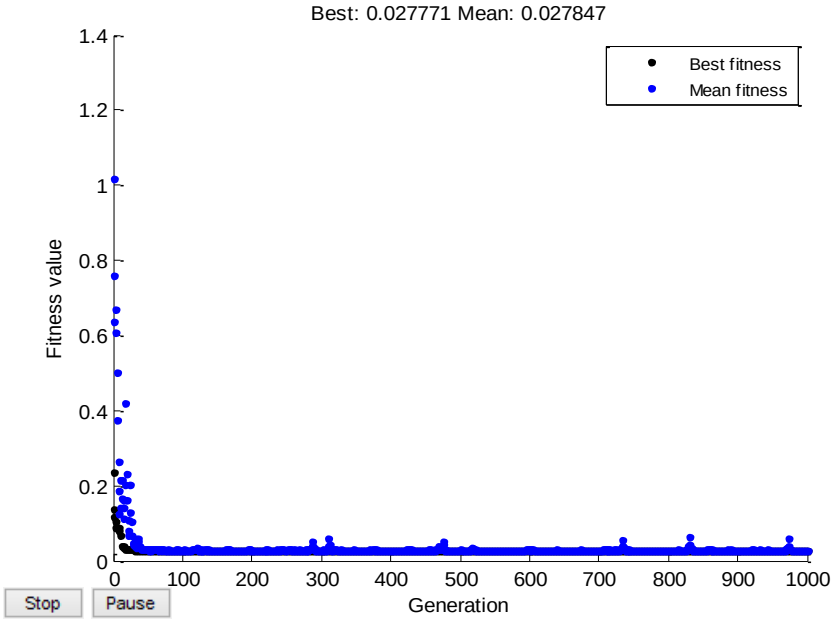

Fig. 3: Optimum Level Fitness

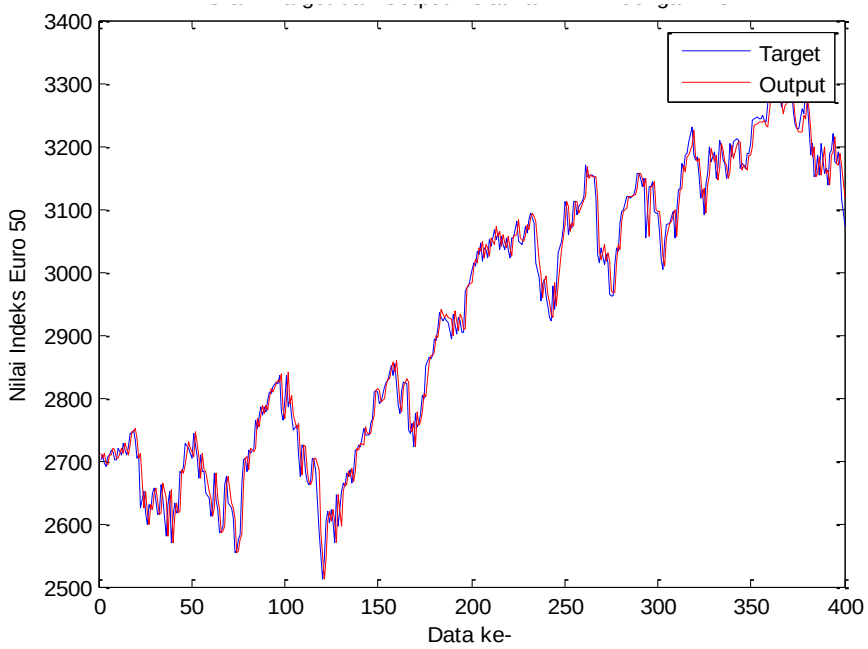

Fig. 4: in Sample Testing

Based on figure 2 seen that process AG stopped after reached generation to 1000. In addition, the fitness produced by, convergence and reached an optimum level that is with the value *of* fitness best 0.027771 and the average rate of fitness 0.0027847.

While the weight or optimum parameters that, as follows:

Table.1: Summary of optimum parameters.

w_{bn}	w_{in}		v_{bo}	v_{no}
-1.3287	1.7477	1.0442	0.3401	-0.9997	0.3063
-0.0469	1.3404	1.6558	0.5563	-0.0469	0.3063

From the weight or parameters that unite the BPNN for time series can be written in the form similarities as follows:

$$\hat{X}_t = -0.9997 + \frac{0.3063}{1 + \exp(-(1.3287 + 1.7477X_{t-1}))} + \frac{0.3063}{1 + \exp(-(0.0469 + 1.3404X_{t-1}))}$$

Based on Fig.4 comparison target and output training BPNN-AG seen that the training network has his prediction that is quite accurate information that is shown by the close target line (blue) with the output (red). But, even though it is still needed performance evaluation network in general to see the result of a network testing BPNN-AG. While to test result network, as follows:

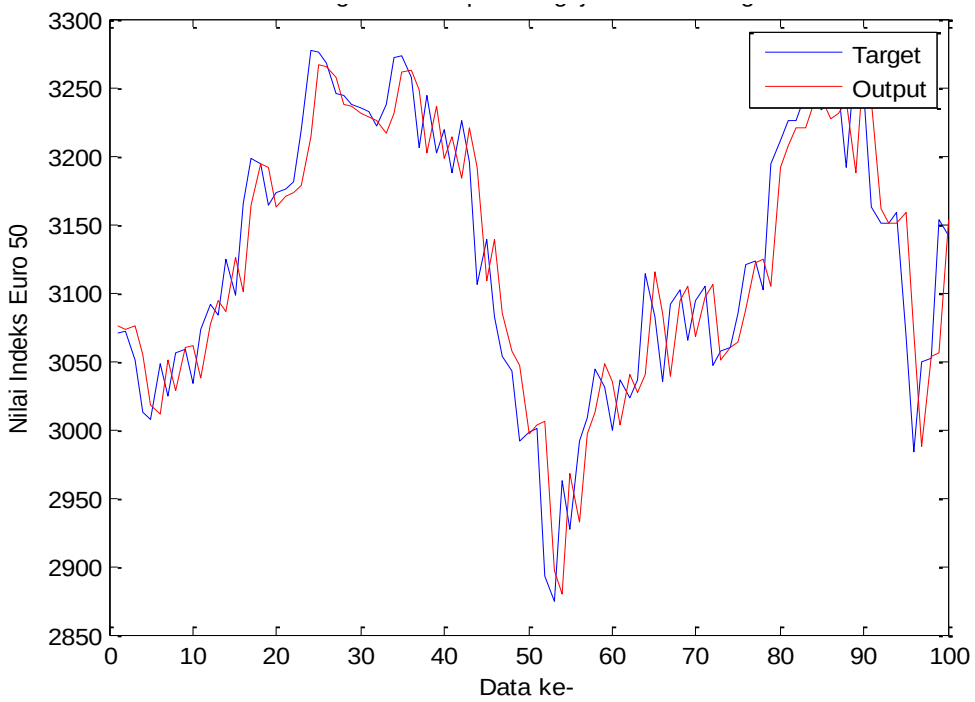

Fig.5: Out Sample Training

Testing by using the weight or parameters that have been an optimum result from the training. Based on a picture comparison target and output training BPNN-AG seen that testing network has his prediction that is quite accurate information that is shown by the close target point (blue) with the output (a red nodule). Model can be used to predict the index euro 50.

V. CONCLUSION

Genetic algorithm (AG) that is one of the alternative methods of learning that can be used to train network Back Propagation Neural Network in share price index data euro 50 . This is shown with an error that produced by the results of the training and testing the mse training=776.9827 rmse training=27.8744 and mse testing= 1543.3 and rmse testing=39.2852. In addition, analysis of visual shows that AG gives a prediction that is quite accurate information that is shown by the close target with output while weight or parameters that produced by has reached an optimum level in second-generation 1000 with the best fitness and the average 0.027771 the *fitness* of 0.0027847.

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