

Architecture of Backpropagation Neural Network Model for Early Detection of Tendency to Type B Personality Disorders

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Abstract-Personal disorder is a type of mental illness. People with personal disorder cannot respond changes and demands of life in normal ways. Women with type B personal disorder tend to have high risk of violence. It is important to make early detection of this personal disorder, so that it can be anticipated properly. This paper reports an architecture model of back propagation neural network (BPPN) for early detection of type B personal disorder. The back propagation process divided into two phases, training and testing. The training process used 43 data and the testing process used 34 data. The output classified into 4 diagnosis categories of type B personal disorder, namely: anti-social, borderline, histrionic, and narcissistic. The optimal parameters of BPPN model consist of maximum epoch of 1000, maximum mu of 10000000000, increase mu of 25, decrease mu of 0.1, and neuron hidden layer of 25. The MSE of training is $3.07E-14$ and MSE of testing is $1.00E-03$. The accuracy of training is 90.7%, while the accuracy of testing is 97.2%.

Keywords: back propagation, early detection, neural network, personality disorders

1. Introduction

Mental Health of America defines personality disorder as a setback that occurs in the internal and external of the human self where the person tends to be inflexible, rigid and unable to respond to changes and the demands of life [1]. Meanwhile, according to Diagnostic and Statistical Manual (DSM) IV, personality disorders are patterns of experience and inner behavior that deviate significantly and causing disorder. [2]

The both definitions refer to the inflexibility of behavior patterns in thought so that it can produce an impact on personal social life. A study by Danie Martin de Barros and Antonio de Pádua Serafim, stated that personality disorders of antisocial and borderline are highly predicted to make violence [3]. Research conducted by Riikka Arola et al., found that borderline personality disorder is a factor of violence attacks by women [4].

Early detection of personality disorder is needed so that it can be anticipated properly. The lack number of experts in the field of clinical psychology causing difficulties for people to obtain the information, therapy, and treatment that they should have. Through this research, with the application of artificial neural networks, it is expected to be able to construct a modeling to initiate

early diagnosis of the type B personality disorder tendency.

Artificial Neural Network (ANN) is a concept of artificial knowledge in the field of artificial intelligence that made by adopting the human nervous system in the brain. In the journal Disease-Free Survival Assessment by Artificial Neural Networks for Hepatocellular Carcinoma Patients after Radio Frequency Ablation [5] stated that the artificial neural network model can recognize patterns of data through the learning process and has been applied to attain medical decision support. The study conducted by Panpan Hu stated that artificial neural networks can be used to analyze patterns of psychological patients, where the ANN model developed has a high accuracy training level with an average of 98.2%. ANN has a good training ability with a sufficient prediction level and the method can support in determining the diagnosis based on the results of the analysis [6]. Elvia Budianita and Muhammad Firdaus reported the method of artificial neural networks use Learning Vector Quantization 2 (LVQ2) in diagnosing psychiatric illnesses in which has a good accuracy of 90% [7]. While Tri Nur Oktavia et.al, reported the expert system in diagnosing hysterical personality disorders. The results of the expert system are compared with the results of the experts with a percentage of accuracy of 83.01% [8]

The novelty of this study is the use of rule-based

interviews with the experts as input data during the training phase. And it is projected that this research can contribute to the discipline of clinical psychology by providing the results of analysis and diagnosis of type B personality disorder, so that preventive action can be taken as early as possible.

2. Research Methodology

a. BPNN Procedures

The procedure for developing the proposed BPNN model is as follows:

- Step 1: Data preparation, conducted by collecting the necessary data. Data collection is performed in 2 ways, by collecting primary data and collecting secondary data. Primary data obtained from expert rule-based data. Whereas secondary data obtained from observation women at a Hospital in Jakarta and also through semi-structured interviews with experts, some psychiatric doctors and psychologists.
- Step 2: Constructing a decision tree and rule based on the decision tree. Constructing rule-based is performed using if-then rules as in the expert system. Constructing a rule is based on data that has been collected.
- Step 3: Training Stage: Symptom data will be analyzed to be the result of back propagation neural network training. Data from the analysis of symptoms are in the form of input data and output data which will become training data for artificial neural network architecture. The training data utilize the calculation of the average value to get the target value. The training process with a separate target value used for artificial neural networks can recognize each personality disorder separately [9]. The results of the training will be used to predict the tendency for personality disorders.
- Step 4: The input value is changed to a random value with a range [0,1]. Inputs used in the system are data of symptoms that have been represented in the numerical form with variables 0 (No) and 1 (Yes).
- Step 5: Determining the activation function and parameters used in the BPNN model. The activation function is used to control the output value to match a predetermined one. In this model, the activation function is binary *sigmoid*. Iteration will be stopped if the maximum value of the epoch is 1000, 3000, and 5000, the error goal is 0, the mean square error is close to 0 and the result of regressions is close to 1.

- Step 6: Determining the number of hidden layer neurons from 1 hidden layer used. Hidden layer neurons are determined by trial and error, which means that the fastest and most precise learning outcomes will determine the number of hidden layer neurons. The variations in the number of hidden layer neurons used are 15, 25, and 35. The Mu Increase variations used are 5, 10, and 25. The Mu Decrease variations are 0.05, 0.1, and 1. The training function is *trainbr* (Bayesian Regulation Back Propagation)
- Step 7: Testing parameters in the BPNN model. Where the weight of ANN from the training phase will be implemented into the testing phase by inputting the symptoms.
- Step 8: The output result is a type of personality disorder tendencies.

b. Data Collection

This research is a qualitative research as the symptoms of type B personality disorder are obtained from interviews and processed into ruled based. The research instrument is a tool for collecting data needed for research. The type of research instrument used was interviews. While quantitative data are questionnaires in the form of tendencies of personality disorder type B in respondents. Data is collected in two ways including:

1. Primary data, obtained from rule-based data based on interviews with experts.
2. Secondary data, data of observations and semi-structured interviews conducted to two fields of expertise, psychiatric doctors and psychologists.

The data collection includes:

- 1) Type of Personality Disorders
Data of types of personality disorders are data according to the Diagnostic and Statistical Manual of Mental Disorders, presented in table 1. [2]

Table 1. Data on type B of personality disorders

Target Code	Type of Personality Disorders Type B
T1	Borderline
T2	Antisocial
T3	Narcissistic
T4	Histrionic

The type B of personality disorders are classified into 4 types, as follows:

- a) Antisocial is a pattern of ignorance, and violation of the rights of others.
- b) Borderline is a pattern of instability in interpersonal relationships, self-image and marked by impulsiveness.

- c) Histrionic is a pattern of emotional and excessive attention.
- d) Narcissistic is a pattern of grandeur, the need for admiration, and lack of empathy.
- 2) General Symptoms Data
General symptom data are symptom data that are visible and also felt by the patient [10]. General disorder data is presented in Table 2.
- 3) Type B Personality Disorder Symptoms Data
Personality disorder data are symptoms that are felt by the patient. These data are classified according to predetermined types of personality disorders. Data on personality disorders can be seen in Table 3.

Table 2. General Symptoms Data

1	The ability to understand yourself, others and events are weak
2	Emotional frequency range to the weak emotions (too far)
3	Weak interpersonal function
4	Weak emotional control
5	Inflexible in various fields of social life
6	Social life between people both from various environments is not good

Table 3. Symptoms Data

No.	Symptoms	Type of Disorder
G1	Excessive imagination or avoidance of reality	Borderline
G2	Pattern and intensity of unstable interpersonal relationships	
G3	Unstable self-identity	
G4	Impulsive, at least in two areas that have the potential to self-destruct (shopping, sex, drug abuse, careless driving, greedy)	
G5	Repeated suicidal behavior or behavior that hurts others/him/herself	
G6	Mood instability	
G7	Chronic empty heart feeling	
G8	Emotions that are not in the atmosphere/difficult to control anger	
G9	Severe dissociative symptoms	
G10	Often violates the norm	Antisocial
G11	Lies often, likes to use aliases, deceives others for personal gain	
G12	Impulsive when plans are not achieved	
G13	Easy to have bad-tempered and aggressive, especially in physical fights	
G14	Ignores the security of him/herself or others	
G15	Ignores the security of him/herself or others	
G16	Be indifferent	
G17	Exaggerates achievements and talents, hoping to be recognized as superior without commensurate achievement	Narcissistic
G18	Busy with fantasies of success, strength, brilliance, beauty, or unlimited love	
G19	Believes that he/she is "special" and unique, only wants to be recognized with other people or special status (or institutions)	
G20	Requires excessive admiration	
G21	Has the feeling of excessive rights	
G22	In exploitative inter-commercials, that is, utilizes other people to achieve their own goals	
G23	Lack of empathy: do not want to recognize the feelings and needs of others	
G24	Often envies others or believe that others envy him	
G25	Shows arrogant behavior	

No.	Symptoms	Type of Disorder
G26	Uncomfortable in a situation where she/he is not the center of attention	Histrionic
G27	Interaction with others is often characterized by seductive and provocative sexual behavior	
G28	Shows expressions of emotions that are fast shifting and superficial	
G29	Consistently uses physical appearance to attract attention	
G30	Has a style of speech that is too impressionistic and lacks detail	
G31	Shows self-dramatization, theatrics, and excessive emotional expression	
G32	Predictable, i.e. easily influenced by other people or circumstances	
G33	Thinksof a more intimate relationship/wants more intimacy	

c. Decision Tree & Rule-based

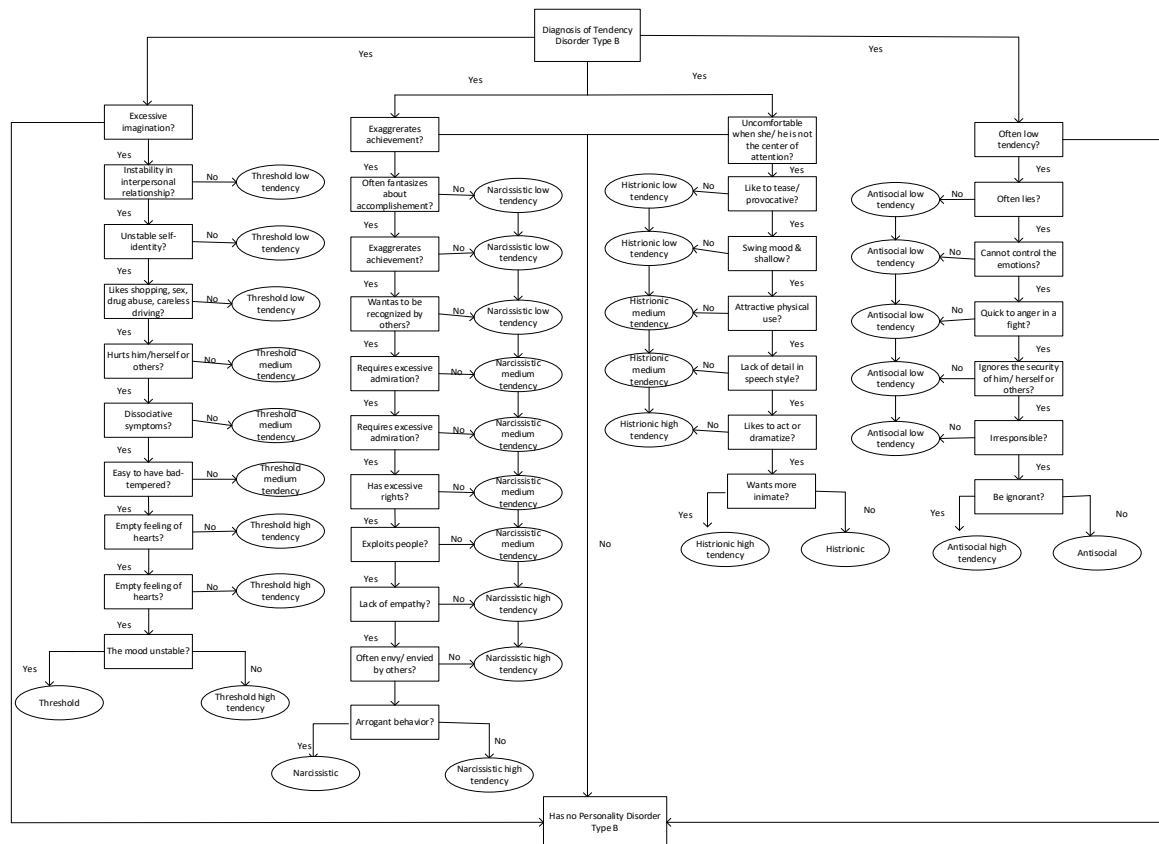


Figure 1. Decision Tree

The decision tree of symptoms and personality disorders is formulated as a tool in composing decisions (decision support tool) and identifying the relationship between the factors that influence a setback. Figure 1 illustrates the decision tree of symptoms and personality disorders.

The nodes in the decision tree are symptoms, while the bottom nodes are decisions. Furthermore, rule-based is made based on the decision tree. Rule-based construction will be used as an input layer in the architecture modeling of BPNN.

Rules-Based System

- a) Rule 1
IF the ability to understand oneself, others and

- events is weak
- OR** the emotional frequency range in emotions is weak (too far)
- OR** the interpersonal function is weak
- OR** emotional control is weak
- OR** is not flexible in various fields of social life
- OR** social life between people from both different environments is not good
- THEN** checks for personality threshold/antisocial/histrionic/narcissistic type
- ELSE**
- THEN** tends personality disorders
- b) Rule 2: check borderline personality disorder
- IF** excessive imagination/avoid reality

- OR** unstable and intense patterns of marked interpersonal relationships that are unstable
OR self-identity is unstable
OR is impulsive, at least in two areas that have the potential to self-destruct (shopping, sex, drug abuse, careless driving, greedy)
OR repeats suicidal behavior/behavior that hurts others or him/herself
OR mood instability
OR chronic empty feeling of heart
OR emotions that are not in the atmosphere/
 difficult to control anger
OR severe diss-associative symptoms
THEN likelihood of borderline personality disorder
- b) Rule 3: check personality disorders
IF often violates the norm
OR often lies, likes to use aliases, deceives others for personal gain
OR is impulsive when plans are not achieved
OR is quick to anger and aggressive, especially in physical fights
OR ignores the security of him/herself or others
OR is not responsible
OR be indifferent
THEN antisocial personality disorder tendencies
- c) Rule 4: check narcissistic personality disorder
IF exaggerates achievement and talent, hoping to be recognized as superior without commensurate achievement
OR is preoccupied with fantasies of success, strength, brilliance, beauty, or infinite love
OR believes that he/she is “special” and unique, only wants to be recognized with other people or special status (or institutions)
OR requires excessive admiration
OR has a feeling of excessive rights
OR is exploitative inter-commercial, which is utilizing other people to achieve their own goals
- OR** Lack of empathy: do not want to recognize the feelings and needs of others
OR often envies others or believes that others envy them
OR shows arrogant behavior
THEN tendency for narcissistic personality disorder
- d) Rule 5: check histrionic personality disorder
IF is uncomfortable in situations where it is not the center of attention
OR interactions with others are often characterized by seductive and provocative sexual behavior
OR displays emotional expressions that are fast shifting and superficial
OR consistently uses physical appearance to attract attention
OR has a speaking style that is too impressionistic and lacks in detail
OR shows excessive self-dramatization, theatrics, and emotional expression
OR is predictable, that is easily influenced by other people or circumstances
OR consider relationships more intimate/want more intimate
THEN tendency for histrionic personality disorder

d. BPNN Architectural Model Design

Artificial Neural Network is a form of innovative learning, statistical models that mimic neuronal functions, able to identify patterns and separate them linearly by providing weight values numeric input for each and adjust it to the data sample [11]. Artificial Neural Networks can use parallel processing to predict solutions to complex variable data. The design of the BPNN architecture model for early detection of personality disorder tendencies is shown in Figure 2.

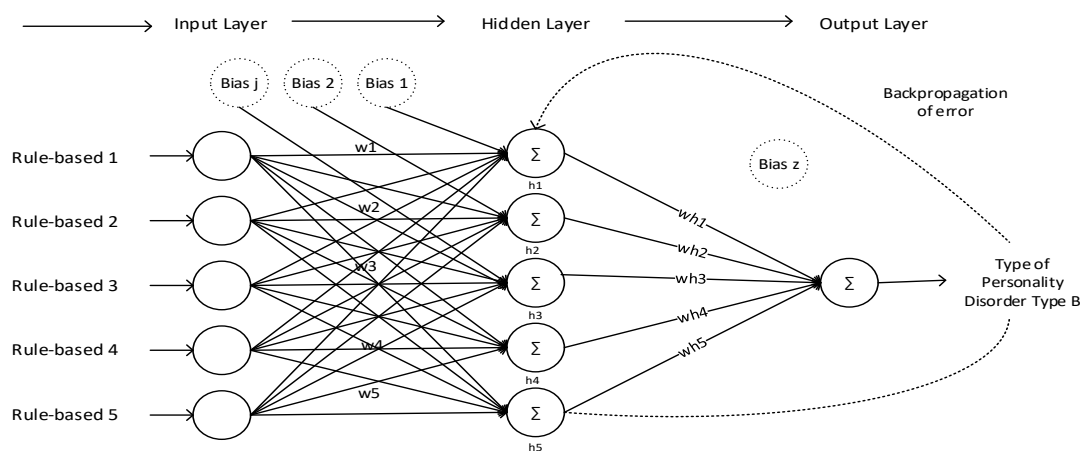


Figure 2 BPNN Architecture Model of Detection of Type B Personality Disorders

The architecture consists of three layers: input layer, hidden layer, and output layer. The back propagation learning algorithm consists of three stages: forward propagation of input signals, back propagation of errors, and weighting of updates. By spreading the input signal to the front (output), the first back propagation algorithm calculates the output for each vector included in the training data set. The next process is modifying the weights of each input vector. An error in the output neuron spreads in the reverse direction from the output layer to the input layer [12]

3. Discussion Results

a. Application of Artificial Neural Networks

The symptoms obtained from experts are processed into the training data. The processing of symptoms data becomes an input parameter for the training process. Meanwhile, the output data are in the form of personality disorder type B. Input data scale is in the form of 0 and 1, 0 for not having these symptoms and 1 for those who have these symptoms. For the output in the form of a scale from 0 to 1, the higher the value, the higher the tendency. In the target data, it is made into four targets, each of which represents symptoms of personality type B.

The data training process is the first step conducted to determine training data to get the results of the

training data. The stage of the training divided into several processes, as follows:

- 1) Establishing training data, training data are obtained from the processing of symptoms.
- 2) Determining the activation function, the number of hidden layers and the training function. Determining the number of hidden layers according to Jeff Haeton. Hidden layers can be determined based on the complexity of the application, the rules are as follows:
 - Problems representing linear programs, so the number of hidden layers is only 0.
 - Problems representing functions that contain a mapping from space to another space, so the number of hidden layers is 1.
 - The problem represents that it can estimate all the mapping, then the number of hidden layers is 2. For more than 2 hidden layers, learning automation is needed.
- 3) Entering the maximum variable *epoch*, a number of *neurons*, *error goal*, *max fail*, *mu ins*, and *mu dec*.
- 4) It is a process of trial and error (repeating until getting optimal results), if we get poor training results, then the variables entered into process four and do the retraining process.
- 5) It is a training process.
- 6) Saving the results of the training in the form of weights for the training to be used in the application.

Table 4. Training and Testing Results

No	Epoch	Neuron Number	Mu Incr	Mu Decr	MSE Training	MSE Testing	Regr Train	Regr Test	Train Accuracy (%)	Test Accuracy (%)	Time
1	1000	15	5	0.05	1.04E-14	2.10E-03	1	0.9937	86	88.2	0:00:02
2	1000	15	5	0.1	4.704E-14	0.0022	1	0.9923	81.4	79.4	0:00:02
3	1000	15	5	1	8.62E-17	1.90E-03	1	0.9937	90.7	91.2	0:00:03
4	1000	15	10	0.05	1.51E-15	2.90E-03	1	0.9921	88.4	88.2	0:00:01
5	1000	15	10	0.1	1.37E-14	2.80E-03	1	0.9920	86	73.5	0:00:02
6	1000	15	10	1	1.83E-12	3.10E-03	1	0.9891	88.4	76.5	0:00:01
7	1000	15	25	0.05	2.28E-14	3.30E-03	1	0.9889	90.7	76.5	0:00:02
8	1000	15	25	0.1	1.72E-15	3.00E-03	1	0.9908	90.7	82.4	0:00:01
9	1000	15	25	1	1.24E-17	2.30E-03	1	0.9918	83.7	82.4	0:00:09
10	1000	25	5	0.05	6.41E-15	9.27E-04	1	0.9970	83.7	94.1	0:00:14
11	1000	25	5	0.1	4.62E-16	8.82E-04	1	0.9966	86	88.2	0:00:08
12	1000	25	5	1	2.28E-14	8.25E-04	1	0.9971	88.4	94.1	0:00:57
13	1000	25	10	0.05	1.33E-13	1.10E-03	1	0.9969	86	88.2	0:00:07
14	1000	25	10	0.1	4.95E-16	9.94E-04	1	0.9966	83.7	91.2	0:00:08
15	1000	25	10	1	1.90E-14	8.97E-04	1	0.9972	81.4	91.2	0:00:04
16	1000	25	25	0.05	6.84E-15	8.61E-04	1	0.9971	90.7	91.2	0:00:09
17	1000	25	25	0.1	3.07E-14	1.00E-03	1	0.9971	90.7	97.1	0:00:04
18	1000	25	25	1	1.23E-13	1.00E-03	1	0.9971	86	94.1	0:00:03
19	1000	35	5	0.05	1.15E-14	5.14E-04	1	0.9985	88.4	97.1	0:00:22
20	1000	35	5	0.1	1.59E-15	4.73E-04	1	0.9983	90.7	97.1	0:00:21

No	Epoch	Neuron Number	Mu Incr	Mu Decr	MSE Training	MSE Testing	Regr Train	Regr Test	Train Accuracy (%)	Test Accuracy (%)	Time
21	1000	35	5	1	1.14E-14	4.69E-04	1	0.9982	83.7	94.1	0:00:21
22	1000	35	10	0.05	2.69E-16	5.31E-04	1	0.9985	90.7	97.1	0:00:11
23	1000	35	10	0.1	4.35E-17	4.70E-04	1	0.9984	90.7	97.1	0:00:23
24	1000	35	10	1	5.39E-15	5.11E-04	1	0.9982	81.4	91.2	0:00:11
25	1000	35	25	0.05	1.51E-14	4.68E-04	1	0.9984	83.7	97.1	0:00:18
26	1000	35	25	0.1	3.37E-15	6.09E-04	1	0.9984	83.7	97.1	0:00:18
27	1000	35	25	1	4.97E-16	4.96E-04	1	0.9984	83.7	97.1	0:00:18
28	3000	15	5	0.05	3.44E-14	2.00E-03	1	0.9932	83.7	88.2	0:00:03
29	3000	15	5	0.1	1.81E-15	2.30E-03	1	0.9921	79.1	88.2	0:00:02
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75	5000	35	5	1	3.56E-15	4.94E-04	1	0.9982	88.4	94.1	0:00:35
76	5000	35	10	0.05	2.39E-14	5.94E-04	1	0.9984	86	97.1	0:00:11
77	5000	35	10	0.1	1.03E-16	5.74E-04	1	0.9978	79.1	91.2	0:00:23
78	5000	35	10	1	6.72E-15	4.78E-04	1	0.9984	86	94.1	0:00:17
79	5000	35	25	0.05	9.51E-15	4.93E-04	1	0.9985	86	97.1	0:00:19
80	5000	35	25	0.1	7.07E-15	5.14E-04	1	0.9986	86	97.1	0:00:10

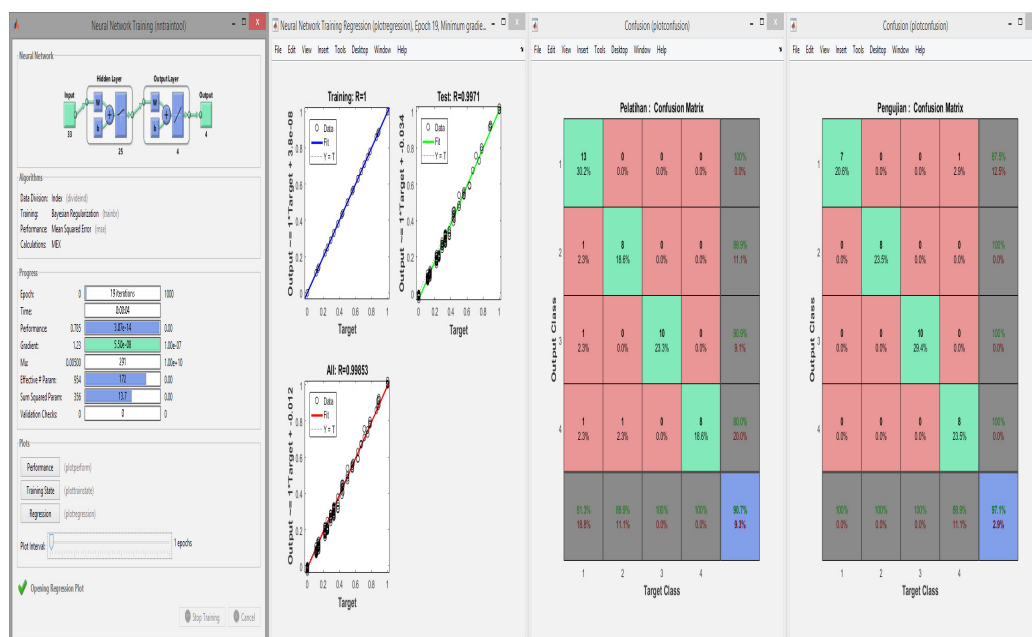


Figure 3. Training Results

Table 4 indicates the best value of the criteria with high regression values, low MSE values (close to 0), training accuracy values (close to 100%) and short training time. The training parameters used in the development of architectural models are optimal training parameters. Training and regression results are shown in Figure 3 and Figure 4.

Figure 4 presents the testing regression results. Regression of artificial neural network using *Matlab* is

how much data that does not deviate, and data that is not outside the line (fit) is non-distorted. Data that deviates from the line (fit) is data that is not recognized by artificial neural networks. The graph can also be viewed as the results of these deviations, the data (round) which is in the blue line (fit) is data that does not deviate. These data are already parallel with the line (fit). It can be concluded that the training process is successful with a regression value of 1 of 1.

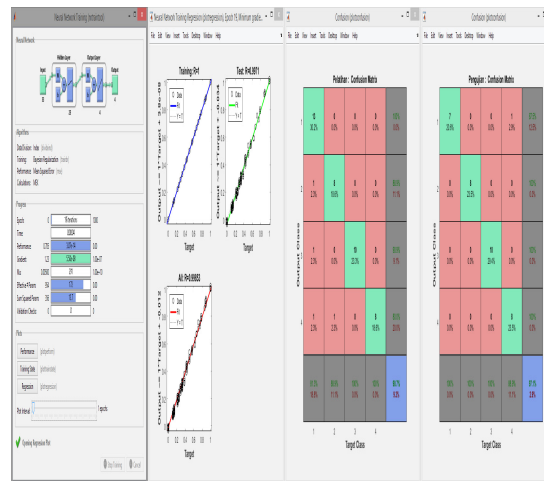


Figure 4. Testing Regression Result

Table 5. Optimal Training Parameters

Training Parameter	Value Parameter
Maximum Epoch	1000
Mu Max	10000000000
Mu increase	25
Mu decrease	0.1
Error goal	0
Max fail	0
Neuron Hidden Layer	25

The result of the training MSE is $3.07E-14$, the result of the MSE Testing is $1.00E-03$, the result of the training regression is 1, the result of the testing regression is 0.9971 and the taken time is 0:00:04 with the training accuracy level of 90.7% and the accuracy of the testing of 97.1%.

The optimal training and testing parameters will be the default parameters on the training page to make it easier for users. These parameters can be seen in Table 5.

4. Conclusion

The optimal value of BPNN architecture parameters for early detection of personality disorder in this research are: maximum epoch: 1000, mu max: 10000000000, mu increase: 25, mu decrease: 0.1, error goal: 0, max fail: 0, and neuron hidden layer: 25. MSE of training is $3.07E-14$, MSE of testing is $1.00E-03$. The training regression is 1, while the testing regression is 0.9971 with the taken time of 0:00:04. The accuracy of training is 90.7%, and testing accuracy of 97.2%, showing that the architecture of BPNN model provides very good accuracy.

Training on the multi-layer back propagation used activation function *sigmoid bayesian trainbr* that provides unlimited range of input value and limited range of 0 to 1 for output value. Thus, the data input has to be normalized to the range of 0 to 1, so the data output can be adjusted into the range of input value. Further research with larger data is needed to examine further the performance of the architecture of BPNN model.

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