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by Okfalisa Okfalisa

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Application of Nguyen Widrow Weight Initialization Algorithm and Backpropagation Neural Network Method to Diagnose Diabetes Mellitus Disease

Elvia Budianita[1], Okfalisa[2], Hidazri Dermawan[3]
[123]Departement of Informatics Engineering, Faculty of Science dan Technology, UIN Sultan Syarif Kasim Riau
Jl. HR. Soebrantas No. 155 Simpang Baru, Panam, Pekanbaru, 28293
Email: elvia.budianita@gmail.com, okfalisa@gmail.com, hidazri.dermawan@students.uin-suska.ac.id

Abstract - Diabetes Mellitus (DM) is a chronic disease caused by the body's inability to produce hormone insulin or due to ineffective inhibition of insulin production. This research applied the algorithm of Nguyen Widrow weight initialization and Backpropagation Neural Network (BPNN) method to diagnose and classifiythe disease into DM type I, type II, and DM Neuropathy. This used 150 clinical data from laboratory and parameter learning rate (α) in 0.01 to 0.09, epoch in 5 to 30, input, hidden, and output layer respectively [19; 19; 2], [19; 25; 30], [19; 30; 2], and data testing in scale 90: 10%, 80: 20%, 70: 30%. As the result, data testing in 90: 10%, α is 0.03, the epoch in 15 and hidden layer in 30 became the best accuracy with 93.33%. For testing, random weight provided the best accuracy with 66.67%. The combination of these methods has been successfully and effectively used in diagnosing DM disease.

Keywords: Backpropagation Neural Network; Diabetes Mellitus; Nguyen Widrow

1. Introduction

Diabetes Mellitus (DM) is a chronic disease caused by the body's inability to produce insulin hormone or due to ineffective inhibition of insulin production. This characterized by high levels of sugar in the blood. This disease requires care and treatment in a long time, both to prevent complications and in the treatment of pain. The main risk factors are unhealthy eating, obesity, lack of motion, smoking and lifestyle. Increased cases of Diabetes Mellitus is very rapid in the ASEAN region, including Indonesia. In Jakarta, the incidence of diabetes increased from 1.7 percent in the 1980s and rose again to 5.7 in the 1990s and rose again to 12.8 in 2000. Globally, in 2010 Indonesia was ranked 9th as a contributor to the case of diabetes. According to the International Diabetes Federation data in 2012, cases of diabetes in Indonesia has reached 7.6 million and in seventh. (Tribune, 2013). Therefore, it takes an application about DM disease that can help people to know the symptoms and types of DM disease experience. One application of technology that can be used for the classification between symptoms of the disease and the type of disease is Artificial Neural Network (ANN). ANN is a representative of the neural network that exists in the human brain so the neural network can work like a human mindset. ANN has the advantage of learning adaptive. Adaptive learning is the ability to learn how to do work based on data provided for initial training or experience and can create own organization or representation of the information it receives during the learning period. The research that has been conducted on ANN among others is research conducted by (Adha, 2017) about the classification of diabetes mellitus disease using Backpropagation Neural Network method. The research use initialization of random weight which yields accuracy equal to 86.67%. Further research by (Romanus, 2013) on the analysis of the use of the Nguyen Widrow algorithm in the backpropagation neural network in renal disease acquired 89.77% accuracy. In addition, research conducted by (Khushboo, et al, 2014) on image compression using Backpropagation method and Initialization Nguyen windrow, all weights in the network are adjusted in an identical way, thereby preventing and reducing function errors. While the weight on the backpropagation method usually initialized with the small random value. Therefore, conducted research on the application of weight initialization algorithm to diagnose diabetes mellitus using Backpropagation Neural Network (BPNN) method is used to determine the accuracy level and compare how much accuracy between initialization of random weight and Nguyen Widrow.

2. Material and Methods

2.1Artificial Neural Network (ANN)

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Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the biological system ofnerves, such as information processes in the human brain. A key element of this paradigm is the structure of an information processing system consisting of a large number of interconnected processing elements (neurons), working simultaneously to solve a particular problem. The workings of artificial neural networks such as the workings of humans, namely learning through example.

2.2 Backpropagation Neural Network (ANN)

The backpropagation ANN model is a development of perception model. This architecture was first proposed by Rumellhart and McClelland in 1986. The main feature of this neural network is the possession of three types of network layers are fully connected, namely: the input receiver network, hidden network, and output network. Network training is done by providing input vectors and output vectors (training datasets).In artificial neural networks, consists of several stages of learning and training process. In the learning process required training data. Training data in this case, DM disease has several variables such as age, sex, blood pressure, history of diabetes, diabetes complications, blood glucose during (GDS) (mg / dl), blood sugar (GDS) 1st day per 8 hours (mg / dl), insulin levels, HbA1c levels, HDL cholesterol (mm / dl), HDL cholesterol levels (mm / dl), triglyceride levels, Hb, leucocytes, platelets, hematocrit, potassium, sodium, and chloride. Target class isincluding DM type I, DM type II, and diabetic neuropathy.

2.3 Nguyen Widrow

Nguyen and Widrow (1990) developed the perception by introducing the rules of network training, known as the delta rule (or often called the small average squares). This rule will change the weights of perception if the output result does not match the desired target. The busy development discussed since the 1990s is the application of neural network models to solve real-world problems.Nguyen and Widrow proposed how to create weights initialization and biases to hidden units so resulting in faster accuracy and iteration. Nguyen-Widrow is used to initialize weights on the artificial neural network which commonly used random weights. The algorithm is as follows (Mishra, Khushboo, et al, 2014):

1. β interval [-0,5:0,5]
2. β = scale factor0,7 $\sqrt{n}$
3. Count $\|v_j\|=\sqrt{v_{1j}^2 + v_{2j}^2 + \ldots + v_{nj}^2}$
4. Weight used as initialization $v_{ij}=\frac{\beta v_{ij}(lama)}{\|v_{j\|}}$
5. Bias used as initializationv_{0j} =bilangan acak antara $-\beta$dan β
6. Bias used as initialization:

   voj = bilangan acak antara – β dan β.

3 Result and Discussion

3.1. Testing Result using Backpropagation Neural Network (BPNN) Parameters

The testing process was conducted by using BPNN parameter based on learning rate value. The difference between random weight and Nguyen Widrow weight was explained in Figure 1. The difference was showed in α = 0.01, 0.02, 0.03 where Nguyen Widrow performed well in 86.67% and 93.33% accuracy.

3.2 Testing Result of Nguyen Widrow Initialization Algorithm

Apart from the training data, the learning rate value is also required during the learning process. The limit value of learning rate is 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, and 0.09. The maximum limit of Epoch obtained is Epoch 15. The threshold value for y_0 and y_1 used in the testing process is obtained from the test results of data learning process per learning rate and Epoch. It is done from the lowest Epoch which are Epoch 5, Epoch 10, Epoch 15, and the numbers of hidden

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layers are 19, 25 and 30. The ratio of training data and testing data used in this study are 70: 30, 80: 20, and 90: 10.

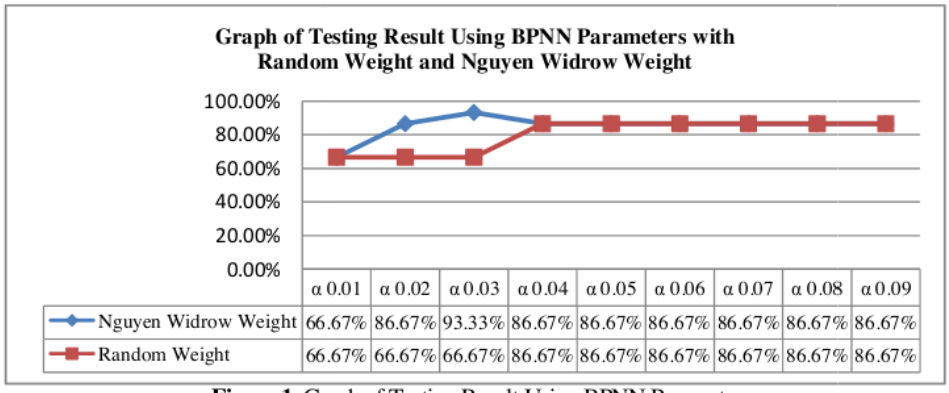

Figure 1. Graph of Testing Result Using BPNN Parameters

Table1. Tests using 90% training data and 10% testing data with 30 hidden layersand Nguyen Widrow weights initialization as follows:

The testing result of Nguyen Widrow initialization algorithm System to diagnose Diabetes Mellitus disease with BPNN method										
Data	15th Epoch with 30 hidden layers									Target
	α 0.01	α 0.02	α 0.03	α 0.04	α 0.05	α 0.06	α 0.07	α 0.08	α 0.09	
1	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3
5	3	3	3	3	3	3	3	3	3	3
6	2	2	2	3	3	3	3	3	3	2
7	2	2	2	2	2	2	2	2	2	2
8	2	2	2	2	2	2	2	2	2	2
9	2	2	2	2	2	2	2	2	2	2
10	2	2	2	2	2	2	2	2	2	2
11	2	1	1	1	1	1	1	1	1	1
12	2	1	1	1	1	1	1	1	1	1
13	2	1	1	1	1	1	1	1	1	1
14	2	2	2	2	2	2	2	2	2	1
15	2	2	1	1	1	1	1	1	1	1
Accuracy	66.67 %	86.67 %	93.33 %	86.67 %	86.67 %	86.67 %	86.67 %	86.67 %	86.67 %	

Note :

= Results match the target

= Results do not match the target

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Based on testing results using a learning rate from 0.01 to 0.09 in Table 1, the highest accuracy obtained is 93.33% with learning rate (α) 0.03. The testing using 90% training data and 10% testing data with 30 hidden layers and random weights initialization as follows

Table 2. Testing Result for data simulation 90:10

The testing result of Nguyen Widrow initialization algorithm System to diagnose Diabetes Mellitus disease with BPNN method										
Data	15th Epoch with 30 hidden layers									Target
	α 0.01	α 0.02	α 0.03	α 0.04	α 0.05	α 0.06	α 0.07	α 0.08	α 0.09	
1	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3
5	3	3	3	3	3	3	3	3	3	3
6	2	2	2	3	3	3	3	3	3	2
7	2	2	2	2	2	2	2	2	2	2
8	2	2	2	2	2	2	2	2	2	2
9	2	2	2	2	2	2	2	2	2	2
10	2	2	2	2	2	2	2	2	2	2
11	2	1	2	1	1	1	1	1	1	1
12	2	1	2	1	1	1	1	1	1	1
13	2	1	2	1	1	1	1	1	1	1
14	2	2	2	2	2	2	2	2	2	1
15	2	2	2	1	1	1	1	1	1	1
Accuracy	66.67 %	66.67 %	66.67 %	86.67 %	86.67 %	86.67 %	86.67 %	86.67 %	86.67 %	

Note :

= Results do not match the target

= Results match the target

Based on the test results in Table 2, the accuracy obtained from learning rate 0.03 is 66.67% while the highest accuracy with learning rate 0.09 is 86.67%.

4. Conclusion

As the conclusion, Nguyen Widrow initialization algorithm System with BPNN method has been successfully applied in diagnosing diabetes mellitus disease. By using the maximum epoch (epoch -15) and learning rate (α: 0.01-0.09), the highest accuracy level is 93.33% in hidden layers 30 and in simulation data training 90:10 with learning rate in 0.03. Meanwhile, the testing result using Nguyen Widrow weight initialization in 30 hidden layers, simulation data trainning in 90:10, and learning rate in 0.03 provided the best accuracy in 93.33%, and Random weight initialization provided 66.67% accuracy. From this, we can conclude that the number of neurons hidden layer, the amount of training data, and the weight initialization can affect the accuracy level.

Acknowledgment

This acknowledgment is given to all parties contribution in this research. The doctor at Sari Medika Clinic, and the staff and lectures in Informatics Department UIN Suska Riau. Hopefully, this research can enrich the theoritical and practice of backpropagation network and initialization of Nguyen Widrow weight method.

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Development of gas calorimeter experiments as a medium of physics learning

Fenny Suhartiwi, Nur Islami, Zul Irfan, Hendar Sudrajat
Faculty of Teacher Training and Education, University of Riau
E-mail: fenny.suhartiwi7874@grad.unri.ac.id

Abstract - Learning media is used to facilitate students in understanding learning materials that are abstract and facilitate the teacher when doing teaching and learning activities. This study aims to produce a suitable gas calorimeter experimental device used in instructional media. Subjects in *Research and Development (R and D)* studies are devices experiment consists of experimental tools and the use of guide books. Five physics education experts participated in the validation process. The data were analyzed descriptively by calculating the validity score of each instrument assessment instrument. The result showed that the average score of validity was 3.238 for experiments with high category and the average score 3.20 for manual of use with high category. The highest validity score is for and ease of indicators tools is 3.50. Of the five validators recommend that the gas calorimeter experimental device is valid used as a medium physics learning medium.

Keywords: Design and Validation, Research and Development, Gas Calorimeter Tools.

1. Introduction

Media is designed to facilitate students in understanding an abstract learning material and also facilitate teachers in conducting teaching and learning activities. And, teaching physics conventionally has been discontinued because it does not attract students, then made a more modern tool to be able to increase interest in physics learning (Bednavora, 2012: 328). Blanka (2013: 1786) in the study of physics requires an approach, both in learning strategies, learning styles, and also needed tools that can support the learning of physics.The development of media in the form of visual aids can improve the attitude of critical thinking and improve student learning outcomes (Hartati, 2010: 1). Karsumi (2012: 8) laboratory-based learning can improve students' reasoning skills in this way hence expected to increase learning outcomes.

A learning device is said to be worthy of use if it has passed the testing phase, either in the form of design and validation of the device (Ricka, 2017: 1). Paidi (2011: 185) some of the steps applied to validate experimental devices first step is design by looking for a problem and conducted preliminary studies, then preparation and manufacture of the device. Validity testing by experts and product revision in the second stage.Validation stage also made some improvements and improvements of the product so it is obtained that the value of the validity of experimental devices with high category and have good quality. Ali. M (2009: 11) the validation results of the electromagnetic field learning media has a very good category with an average score of 3.74 using a Likert scale that has a maximum score of 4. Device validation can also be calculated by using t test, friction force tool able to improve students' critical thinking skill with t value 5,389 with significance level of 0,05 and can increase learning result from 65,24 up to 70,63. So that it can be said that the appropriate friction force (valid) is used in learning, because it can improve critical thinking skills and student learning outcomes (Hartati, 2010: 128).

Trial tools are needed in learning activities. Abstract material in learning for example the heat that can't be seen by the eye of the process of releasing and receiving heat. With the gas calorimeter experiments, the students' understanding of receiving the caloric material is quicker and easier, and the students are also able to present and deduce a data from the experiments conducted. Gas calorimeter experimental devices are expected to be a viable learning medium used in high school physics.

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2. Material and Methods

This research was conducted by using Research and Development (R & D) method by Sugiyono (2015).Research phase is divided into 2, namely design and validation of experimental devices. The design phase includes (1) preliminary study, in order to find a problem of literature study by searching related journals and conducting a short survey to find out the facts of learning problems that are in school environment. (2) Design the product, is the process of designing a gas calorimeter tool by sketching the image and preparing and taking into account the equipment used.(3) Construct the product, assembly of equipment is carried out by following the design process. The next stage of validation is divided into 2, (1) Validation, device testing performed to determine the functionality of the tool assessed by the validator. If there is still a shortage, then the improvement will be done until declared valid. (2) Revision, revisions made to follow up previous validation results that still have some deficiencies and then made improvements to fit the research objectives. The research phase can be seen in Figure 1.

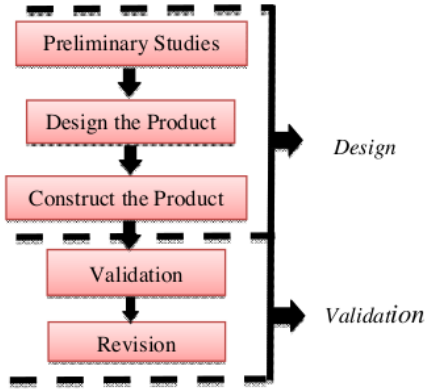

Figure 1. Stages of design research and validation of gas calorimeter experiments

The object of this research is experimental device of gas calorimeter. Validator that examines the object of this research consists of 3 lecturers and 2 high school teachers. Data collection is done by filling the instrument in the form of a questionnaire, then distributed to some validators to get an assessment. Data analysis technique used in this research is descriptive analysis. Assessment on validation questionnaires using Likert scale as shown in Table 1.

Table 1. Category of Validation Sheet Evaluation (Djaali and Pudji, 2004)

No	Category	Score
1	Strongly Agree	4
2	Agree	3
3	Disagree	2
4	Strongly Disagree	1

The average rating category of indicators based on the Likert scale on the experimental device can be seen in Table 2.

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Table 2. Category of Validity

No	Average Score	Category	Value of Validity
1	$3{,}25 < S \leq 4$	Very High	Valid
2	$2{,}5 < S \leq 3{,}25$	High	Valid
3	$1{,}75 < S \leq 2{,}5$	Low	Invalid
4	$1 \leq S \leq 1{,}75$	Very Low	Invalid

3. Result and Discussion

Learning devices that have been made consist of gas calorimeter tools and guidebooks of gas calorimeter usage. The gas calorimeter apparatus has been validated by the validator and is declared valid. In Table 3 is a recapitulation of validation results of gas calorimeter tool consisting of seven indicators. Calorimeter tools can be said to be practical and easy to prepare, whether used or packaged after use, with a value of 3.50 with the category VH (very high). The safety of gas calorimeter tools is also categorized VH with the value of 3.33, the use of non-hazardous materials, is one of the advantages of gas calorimeter tool. Other indicators have less significant value differences. The functionality of this tool belongs to the category H (high) with a value of 3.20, equal to the value on the indicator of economic value, size, and accuracy of use. On the functioning of the tool, it can be said that the tool works well that shows the symptoms and phenomena to be observed. Tools and materials used can be easily obtained and have a price that is still affordable so that the high economic value of the tool. The size of the gas calorimeter tool is easily visible, and can be moved around, so it is easy to be re-packed. This tool shows the desired black principle phenomenon and changes in temperature and pressure so that the accuracy of the use of high-value tools. Not only in terms of usefulness but also the tool must also have aesthetic value, which makes the tool look attractive. From the results of the research conducted, validation of the gas calorimeter tool is considered valid shown in Table 3.

Table 3. Recapitulation of Validation Result of Gas Calorimeter Experiments Tool

No	Indicator	Average	Category
1	Functional	3.20	VH
2	Easiness	3.50	H
3	Safety	3.33	VH
4	Size	3.13	VH
5	Aesthetics	3.20	H
6	Accuracy	3.20	VH
7	Accuracy of use	3.20	H
Average Indicator		3.238	H

The manuals on the use of the gas calorimeter tool is part of the experimental device. So the value of the validity of the book must also be validated by the validator. Validate books have separate questionnaires with calorimeter tools. The indicators and results of the manual assessment can be seen in Table 4.

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Table 4. Recapitulation of Validation Test Result of Gas Calorimeter Experiment Tool Manual

No.	Indicator	Average	Category
1	Accuracy of Content	3.20	H
2	Appearance	3.20	H
3	Easiness	3.20	H
	Average Indicator	3.20	H

The assessment of the manual is assessed simultaneously with the gas calorimeter tool. With category T the results of the average per indicator as well as each indicator. The average value is still in the H category. This value should be better and higher if some refinements are made. Some indicators on tools that show a value below 3.30 should be repaired again so that the gas calorimeter tool has a perfect value. Likewise with the validation of the gas calorimeter manual.

4. Conclusion

Gas calorimeter experimental devices designed and assembled and validated have been valid for use in teaching and learning in schools. The manufacturing process is in accordance with the Research & Development procedure. The gas calorimeter experimental device design consists of gas calorimeter experiments and a usage manual. Validation of gas calorimeter apparatus declared invalid with high category and manual of gas calorimeter usage also stated valid with high category. Thus, the gas calorimeter experimental device was declared as feasible to be used as a medium of learning for physics at school.

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Elvia Budianita[1], Okfalisa[2], Hidazri Dermawan[3]
[123]Departement of Informatics Engineering, Faculty of Science dan Technology, UIN Sultan Syarif Kasim Riau
Jl. HR. Soebrantas No. 155 Simpang Baru, Panam, Pekanbaru, 28293
Email: elvia.budianita@gmail.com, okfalisa@gmail.com, hidazri.dermawan@students.uin-suska.ac.id

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1. β interval [-0,5:0,5]
2. β = scale factor0,7 $\sqrt{n}$
3. Count $\|v_j\|=\sqrt{v_{1j}^2 + v_{2j}^2 + \ldots + v_{nj}^2}$
4. Weight used as initialization $v_{ij}=\frac{\beta v_{ij}(lama)}{\|v_{j\|}}$
5. Bias used as initializationv_{0j} =bilangan acak antara $-\beta$dan β
6. Bias used as initialization:

   voj = bilangan acak antara – β dan β.

3 Result and Discussion

3.1. Testing Result using Backpropagation Neural Network (BPNN) Parameters

The testing process was conducted by using BPNN parameter based on learning rate value. The difference between random weight and Nguyen Widrow weight was explained in Figure 1. The difference was showed in α = 0.01, 0.02, 0.03 where Nguyen Widrow performed well in 86.67% and 93.33% accuracy.

3.2 Testing Result of Nguyen Widrow Initialization Algorithm

Apart from the training data, the learning rate value is also required during the learning process. The limit value of learning rate is 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, and 0.09. The maximum limit of Epoch obtained is Epoch 15. The threshold value for y_0 and y_1 used in the testing process is obtained from the test results of data learning process per learning rate and Epoch. It is done from the lowest Epoch which are Epoch 5, Epoch 10, Epoch 15, and the numbers of hidden

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layers are 19, 25 and 30. The ratio of training data and testing data used in this study are 70: 30, 80: 20, and 90: 10.

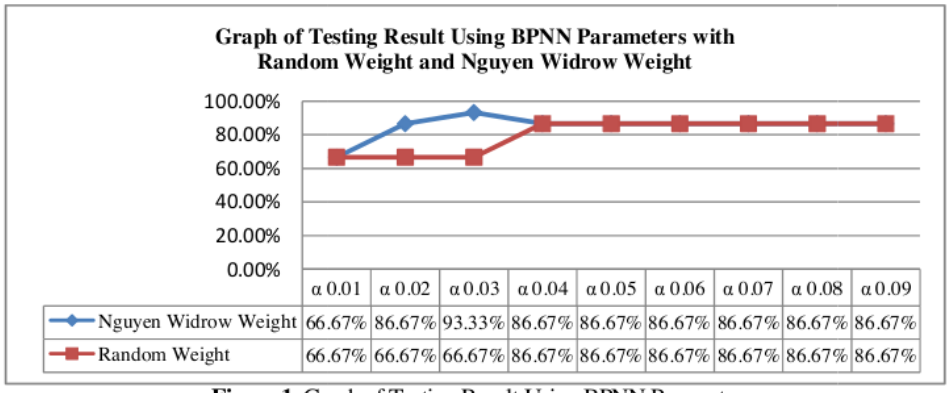

Figure 1. Graph of Testing Result Using BPNN Parameters

Table1. Tests using 90% training data and 10% testing data with 30 hidden layersand Nguyen Widrow weights initialization as follows:

The testing result of Nguyen Widrow initialization algorithm System to diagnose Diabetes Mellitus disease with BPNN method										
Data	15th Epoch with 30 hidden layers									Target
	α 0.01	α 0.02	α 0.03	α 0.04	α 0.05	α 0.06	α 0.07	α 0.08	α 0.09	
1	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3
5	3	3	3	3	3	3	3	3	3	3
6	2	2	2	3	3	3	3	3	3	2
7	2	2	2	2	2	2	2	2	2	2
8	2	2	2	2	2	2	2	2	2	2
9	2	2	2	2	2	2	2	2	2	2
10	2	2	2	2	2	2	2	2	2	2
11	2	1	1	1	1	1	1	1	1	1
12	2	1	1	1	1	1	1	1	1	1
13	2	1	1	1	1	1	1	1	1	1
14	2	2	2	2	2	2	2	2	2	1
15	2	2	1	1	1	1	1	1	1	1
Accuracy	66.67 %	86.67 %	93.33 %	86.67 %	86.67 %	86.67 %	86.67 %	86.67 %	86.67 %	

Note :

= Results match the target

= Results do not match the target

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Based on testing results using a learning rate from 0.01 to 0.09 in Table 1, the highest accuracy obtained is 93.33% with learning rate (α) 0.03. The testing using 90% training data and 10% testing data with 30 hidden layers and random weights initialization as follows

Table 2. Testing Result for data simulation 90:10

The testing result of Nguyen Widrow initialization algorithm System to diagnose Diabetes Mellitus disease with BPNN method										
Data	15th Epoch with 30 hidden layers									Target
	α 0.01	α 0.02	α 0.03	α 0.04	α 0.05	α 0.06	α 0.07	α 0.08	α 0.09	
1	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3
5	3	3	3	3	3	3	3	3	3	3
6	2	2	2	3	3	3	3	3	3	2
7	2	2	2	2	2	2	2	2	2	2
8	2	2	2	2	2	2	2	2	2	2
9	2	2	2	2	2	2	2	2	2	2
10	2	2	2	2	2	2	2	2	2	2
11	2	1	2	1	1	1	1	1	1	1
12	2	1	2	1	1	1	1	1	1	1
13	2	1	2	1	1	1	1	1	1	1
14	2	2	2	2	2	2	2	2	2	1
15	2	2	2	1	1	1	1	1	1	1
Accuracy	66.67 %	66.67 %	66.67 %	86.67 %	86.67 %	86.67 %	86.67 %	86.67 %	86.67 %	

Note :

= Results do not match the target

= Results match the target

Based on the test results in Table 2, the accuracy obtained from learning rate 0.03 is 66.67% while the highest accuracy with learning rate 0.09 is 86.67%.

4. Conclusion

As the conclusion, Nguyen Widrow initialization algorithm System with BPNN method has been successfully applied in diagnosing diabetes mellitus disease. By using the maximum epoch (epoch -15) and learning rate (α: 0.01-0.09), the highest accuracy level is 93.33% in hidden layers 30 and in simulation data training 90:10 with learning rate in 0.03. Meanwhile, the testing result using Nguyen Widrow weight initialization in 30 hidden layers, simulation data trainning in 90:10, and learning rate in 0.03 provided the best accuracy in 93.33%, and Random weight initialization provided 66.67% accuracy. From this, we can conclude that the number of neurons hidden layer, the amount of training data, and the weight initialization can affect the accuracy level.

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