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PREFACE

Assalaamu ‘alaykum warahmatullahi wabarakaatuh,

The CITSM 2018 is in the general area of communication and information technology. It provides a forum for presenting and discussing the latest innovations, results and developments in IT Management & organizations, IT Applications, Cyber & IT Security, and ICT. The main objective of this conference is to provide a forum for engineers, academia, scientist, industry, and researchers to present the result of their research activities in the field of Computer and Information Technology. The primary focus of the conference is to create an effective medium for institutions and industries to share ideas, innovations, and problem solving techniques.

There are 282 papers submission and only 150 papers are accepted and 147 papers have been registered and presented. Accepted papers will be presented in one of the regular sessions and will be published in the conference proceedings volume. All accepted papers are submitted to IEEEXplore. IEEE Conference Number: # 43622. Catalog Number: CFP1837Z-PRT, ISBN: 978-1-5386-5433-0, CFP1837Z-USB, ISBN: 978-1-5386-5434-7.

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Wa billahi taufiq wal hidaayah.
Wallahul muwaffiq ila aqwamit-tharieq.
Wasalaamu ‘alaykumu warahmatullahi wabarakaatuh.

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Improving The Accuracy Of Neural Network Technique with Genetic Algorithm for Cervical Cancer Prediction

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***Abstract*- New cases of cervical cancer in Indonesia more than 13,700 and nearly 7500 deaths caused by this cancer in 2008. Cervical cancer ranked third disease experienced by women around the world and ranked fourth cause of cancer deaths. In 2008, there were 529,800 women diagnosed with cervical cancer and 275,100 of them died from the disease. In this research, we tested the model using neural network with neural network based on genetic algorithm to predict cervical cancer. Several experiments were conducted to obtain optimal architecture and produce more accurate prediction accuracy. Experimental results with various combinations of research parameters showed that experiments using neural network obtained the best accuracy value is 94.51% with AUC value 0.961. While experiments using genetic algorithm based neural network obtained 96.26% accuracy value with AUC value 0.968. The results show that the model formed by neural network based on genetic algorithm produces better accuracy compared to neural network without genetic algorithm. Based on the tests that have been done can be concluded that the genetic algorithm can improve neural network performance in predicting data of cervical cancer.**

Keywords—neural network, genetic algorithm, cervical cancer prediction

I. INTRODUCTION

Keeping reproductive health, make a big difference for survival by keeping their generation a nation. One of the problems to reproductive healthcare in women is found cancer cervix or cervical cancer. In Indonesia incident, cervical cancer places in the first position compared with other cases cancer[1]. Cervical cancer is cancer gynecology tasering happens to women. In Indonesia more than 13.700 new cases of cervical cancer and almost 7500 death caused by these cancers in 2008[2]. Cervical cancer disease in third place in women around the world and ranked fourth cause of death due to cancer.In 2008, there are 529.800 women in the diagnosis cervical cancer and 275.100 including died of this disease[3].

An unusual growth of a collection of cells in the cervix can lead to the establishment of cervical cancer. This change usually takes several years before developing into cancer. By performing routine checks it is possible to detect this cancer at an early stage so that it is easier to handle[4]. Cervical cancer is a primary malignant tumor derived from squamous epithelial cells. Neoplasia intraepitel cervical (nic) or commonly called pre-cancer lesions is a situation which arise before the cancer. Most cervical cancer patients come to try at an advanced stage, because in the early stages of this disease does not cause symptoms[5]. Cervical cancer is cancer which is found at the female reproductive organs, places in the first position followed the ovary and uterine.

Early detection and appropriate treatment can reduce the incidence and death significantly from cervical cancer. From these facts, various examination tests have been developed in order to detect cervical precancer[6]. Research on detection of cervical cancer was performed[7] by proposing Bayesian classifier, linear discriminant analysis (LDA), K-nearest neighbor (KNN), neural network, and support vector machine (SVM). Of the five classification algorithms, Neural Network gives the best results. Other studies[8] also used the Neural Network method, comparing three models of training techniques such as multilayered perceptron (MLP), radial base

function (RBF) and hybrid multilayered perceptron (HMLP) with an Neural Network proposed model called hierarchical hybrid multilayered perceptron (H2MLP) for predict cervical cancer. Research conducted[6] reviewed 103 scientific papers collected from google scholar and Scopus, six types of cervical precancer set data commonly used for examination of cervical cancer (cytology, fluorescent in situ hybridization / FISH, electromagnetic spectra, cervicography, colposcopy, and hyperspectral diagnostic imaging / HSDI) concluded the Neural Network algorithm gives the best accuracy results from other classifiers.

The capabilities of Neural Network have been demonstrated in several applications including speech synthesis, diagnostics, medicine, finance and business, control of robots, signal processing, and other issues falling within the category of pattern recognition and classification[9]. The popular technique used in the Neural Network method is the Back propagation (BP) algorithm. But in practice this method still has some weaknesses among them is the problem of long training time to reach convergent, and also easily trapped in local minima [9]. Back propagation (BP) is one of the topologies of neural network, this model adjusts the network weight and bias by calculating the error gradient. Typically, Back propagation (BP) applies initial weights at random. it can lead to two major problems, namely being stuck in local minima and slow to reach convergence[10].

Global search techniques such as genetic algorithms have been proposed to address the limitations of Back propagation (BP). The genetic algorithm is proposed as one of the potential candidates for optimization of artificial neural network weights [9]. Genetic algorithm (GA) can optimize the connection weight of neural network, so it can overcome the weakness stuck in local minima. Incorporation of Genetic algorithm and Back propagation (BP) can also increase the speed of convergence and generalization capabilities[10]. Genetic algorithms are the most popular type of evolutionary algorithms (EA). Because of its ability to solve complex problems, this algorithm is widely used in the fields of biology, medicine, economics, industry and others who often face optimization problems whose mathematical models are complex or even difficult to build. Neural Network algorithm optimization using Genetic algorithm has been proven in many fields, including biology, used for biological engineering of hydroponic plant production[11], medical field for breast cancer classification[12], Neural Network and Genetic algorithm can also be applied to medical data processing[13], quality of river water prediction[10], predictive impairment of Ready Mix Concrete (RMC) or concrete[14], search engines on the web[15] and customer credit ratings at banks[16]. Genetic algorithm is a good algorithm to overcome the limitations of Back propagation (BP) on the Neural Network algorithm in the classification problem. This algorithm can be used to adjust the weight of connections in hidden and output layers, widely used for Neural Network optimization and training[13].

Improved accuracy that we propose by integrating genetic algorithm on neural network algorithm to produce better accuracy on cervical cancer prediction

II. RELATED WORK

Research on the use of genetic algorithm and Neural Network are one of the research that has been done by many researchers before.

Cervical cancer prediction method done by Qiu, Tao, Tan and Wu, 2007[17] using Neural Network method trained with Levenberg Marquardt (LM) algorithm. Data is divided into two parts of build and test, consisting of 50 women affected by cervical cancer (case group) and 115 women who are not affected by cervical cancer (control group). The initial weight of the network is determined by the LM algorithm. The result of the research shows that Neural Network trained with LM algorithm has a good ability (sensibility = 98%, specificity = 97%).

The combined Neural Network method optimized with Genetic Algorithm has been performed (Ferentinos, 2005)[11] for design problems and training parameters of Neural Network used for biological engineering of fault detection and predictive modeling of hydroponic systems. The results prove the Genetic Algorithm system is able to find a good solution that gives satisfactory accuracy in training and testing Neural Network compared with using trial and error. Neural Network built with Genetic Algorithm gives the smallest mean squared errors (MSE) results when compared to Neural Network built with a manual test.

Other researchers (Zamani, Amaliah & Bilqis, 2012)[12] also use a combination of Neural Network classification method and Genetic Algorithm, where Neural Network method is used to predict breast cancer, while Genetic Algorithm is used to optimize Neural Network parameters such as number of hidden layers and learning rate the resulting accuracy can be better. The results of the combined method of Neural Network and Genetic Algorithm were compared with the Naïve Bayesian method. The experimental evaluation method used is 10 fold cross-validation method. The results of 10 fold cross-validation test showed that the Neural Network method that optimized the parameters using genetic algorithm resulted in a fairly high average accuracy of 97.00%, better than Naïve Bayesian method (NB) which yielded an average accuracy of 96.24 % and also better than the Neural network method with Association Rules (AR) which yields an average accuracy of 95.6%.

The combined algorithm of Neural network and Genetic Algorithm is also proposed (Ding, Cai, Sun & Chen, 2014)[18] for the prediction of river water quality. 23 dimensions of the water quality factor index were reduced to 15 aggregate indexes using Principal Component Analysis (PCA). The weight and threshold value of Neural network are optimized using Genetic Algorithm. The results show Neural network optimization with GA gives the overall accuracy of 91% with MSE value smaller when compared with Neural

network without Genetic Algorithm. The smaller the MSE value, the better the convention. Neural network search process without Genetic Algorithm, the optimal solution cannot be searched and result in decreasing prediction accuracy.

The application of Genetic Algorithm for Neural Network optimization has been done (Chandwani, Agrawal & Nagar, 2015)[14] to predict the reduction of Ready Mix Concrete (RMC) or concrete quality. Genetic Algorithm is used to determine the initial optimal weight and bias of Neural network to minimize the possibility of local trap minima and slow to reach convergent to global optimum. Neural network performance and Genetic Algorithm compared with Neural network performance without Genetic Algorithm. The results showed by the merging of Neural network and Genetic Algorithm, the convergence speed and accuracy of prediction can be improved.

III. METHOD

The proposed method is the application of genetic algorithm and neural network method to predict cervical cancer. Starting from the division of dataset with 10 cross-validation method is data testing and data training, then the data training is processed by neural network method and genetic algorithm. In this research used experiment research. Experimental research involves investigating the causal relationship using a test controlled by the researcher himself.

This stage describes the experimental steps including how to select the appropriate architecture of the proposed model or method to obtain results that can prove that the method used is appropriate. The experimental stages of this research are:

1. Set up the dataset for the experiment.
2. Design the neural network architecture, by including the value of neural network parameters that is (training cycles, learning rate, momentum, and neuron size on the hidden layer).
3. Conducting training and testing of the neural network model and recording the confusion matrix and ROC curves.
4. Design the neural network architecture and genetic algorithm, by including the value of neural network parameters (training cycles, learning rate, momentum, and neuron size on the hidden layer) and genetic algorithm parameter (population size and maximum of generation).
5. Conducting training and testing of neural network model and genetic algorithm and recording the result of confusion matrix and ROC curve.
6. Comparison of confusion matrix and ROC curves in both models.

In choosing the right neural network architecture and producing the best accuracy and AUC value, it is necessary to set the parameters of the neural network. The following parameters are parameters that need to be adjusted[19][20]:

1. Training cycle, learning rate, and momentum

Training cycle is the number of iterations of training that need to be done to get the smallest error. The training cycle value varies from 1 to infinity. Learning rate is to determine how much we change the weights at each step. The Back Propagation network algorithm is very sensitive to the proper setting of the learning rate. If the learning rate is set too high, the algorithm can oscillate and become unstable. If the learning rate is too small, the algorithm will take too long to converge[19]. Momentum is used to increase the speed of convergence. This can be accomplished by adding some changes to the previous weights with the current weights. Low momentum can cause unstable weights that prevent the network from training. High moments can damage the adaptability of the network. To maintain the stability of back propagation, momentum with small numbers <1 is highly recommended[20]. The addition of momentum is intended to avoid significant changes in weight due to the very different data from the other (outliers). If some of the last data given to the network have a similar pattern (meaning the gradient direction is correct), then the weight changes are done quickly. But if the last data entered has a pattern different from the previous pattern, then the change is done slowly.

2. Hidden Layer

Hidden Layer is a collection of neurons that have an activation function applied on it and provides an intermediate layer between the input layer and the output layer. The number of neurons stored in each hidden layer should be calculated. If the number of small neurons is likely to be "underfitting". Underfitting is less networks can detect signals or patterns in data sets. The excessive number of neurons will result in overfitting[21] is the amount of information in the limited training set, not enough to train all the neurons in the hidden layer.

Genetic algorithm parameters such as population size, selection methods, crossover, and mutation play an important role in achieving optimal convergence by setting exact parameter[22] . The following customized parameters:

1. Population size dan Maximum Generation

Population size is the number of chromosomes present in the population. Large population size increases the number of variations/differences that exist within population (population diversity) so that more fitness evaluation is needed. Furthermore, when population size becomes too large, there is a tendency by users to reduce the number of generations to reduce computational effort, since computational effort depends on both population size and number of generations. Reducing the number of generations reduces the overall quality of the solution. On the other hand, the population size is too small to cause the Genetic Algorithm to be premature for the optimal solution.

2. Selection

The selection process determines which chromosomes participate in reproduction to produce the next population according to their fitness values in the current population. In general, this process takes advantage of the fittest solution by giving greater weight when selecting the next generation and leading to a better solution. There are several ways to apply selection in genetic algorithm optimization. Proportionate selection, linear ranking and tournament selection, commonly used in selection methods.

3. Crossover

Crossovers are used to create new chromosomes for the next generation at random by combining the two selected chromosomes of the present generation through the selection process. User-defined crossover rate is how much Crossover reproduction probability will be made. For example, a Crossover rate of 0.9 means that on average 90% of the population undergoes Crossover operations. High crossover rate encourages good mixing of chromosomes. There are several crossover methods available, such as: single point, multi-point, uniform crossover. The choice of the best Crossover method depends on the approach.

4. Mutation

Mutations include updates to populations that randomly modify chromosomes. It rains to change one or more parts of a chromosome. This prevents the population from saturation with a chromosome that assumes all the same and reduces the likelihood of premature convergence. For example, in a string bit representation, mutations are performed by reversing 0 to 1 and vice versa. A large mutation rate increases the chances of destroying a good chromosome. Users can determine the probability of the mutation rate that will occur. For example, if the population size is 100, the string length is 20 and the mutation rate is 0.001 (100x20x0,001 = 2), then on average only two-bit positions will be mutations across the population.

Evaluation Technique

The proposed model of research on prediction of cervical cancer is by applying neural network and neural network based on genetic algorithm. Implementation of neural network algorithm by finding the highest accuracy and AUC value from training cycle, learning rate, momentum and size on hidden layer. Neural network training is done several times in each parameter with value range for training cycle (100 - 1500), learning rate (0.1 - 1), momentum (0.1 - 1) and neuron size (1-30). While the application of genetic algorithm based on genetic algorithm is to get the initial weight and bias through the selection process, crossover and mutation to a group of individuals in one population to produce better offspring based on natural selection. The best offspring will be able to make these weights more likely to achieve a good solution. Adjusted parameters are population size with the range of values (1-10), and the maximum of generation parameters with the range of values (10 - 100).

IV. DATASET

The dataset in this research is secondary data obtained from government hospital taken by Ridwansyah in his research on uterine myoma. Gynecologic patient data with the total of 401 female patients with a lifespan of 20-69 years examined and 205 patients detected by cervical cancer, while 196 other patients were not affected by cervical cancer. The dataset used comes from laboratory results conducted by the hospital. Cervical cancer data consists of 16 variables or attributes. These variables are classified as a predictor variable that is used as a determinant of cervical cancer, and the variable of destination is the variable used as the result of the disease. The predictor variables are age, systole, diastole, temperature, pulse, respiration, status, bleeding after intercourse, feces discharge through the vagina, menstruation longer, whiteness, often tired, urinary discharge, swelling of the leg area, pelvic and hip pain.

V. EXPERIMENT RESULT

Neural network and neural network performance test based on genetic algorithm by determining accuracy value and AUC using Cross Validation.

A. Test results with neural network method

The measurement of accuracy and AUC (Area Under Curve) of the model testing that has been done:

1. Confusion Matrix

Evaluation of the classification model is based on testing to estimate the right and wrong objects. 401 resulted in training data obtained as follows:

accuracy: 94.51% +/- 4.16% (mikro: 94.51%)

	true Serviks	true Bukan Serviks	class precision
pred. Serviks	202	19	91.40%
pred. Bukan Serviks	3	177	98.33%
class recall	98.54%	90.31%	

Fig. 1. Value of Accuracy with Neural network

In the confusion matrix image above can be seen there are 202 cases classified correctly as the cervix (tp) of a total of 401 cases, there are 3 cases of wrong classification that should not be cervix but predicted cervix (fp). Next, there are 177 cases classified correctly instead of cervix (tn), and 19 cases are classified as false which should be cervical predicted not cervix (fn). Figure 1 shows that the accuracy level using the neural network algorithm is 94.51%, and can be calculated to find the accuracy, sensitivity, specificity, ppv and npv results in the following equations:

$$Sensitivity = \frac{tp}{tp+fn} = \frac{202}{202+19} = 0{,}9140 \quad (1)$$

$$Specificity = \frac{tn}{tn+fp} = \frac{177}{177+3} = 0{,}9833 \quad (2)$$

$$PPV = \frac{tp}{tp+fp} = \frac{202}{202+3} = 0{,}9853 \quad (3)$$

NPV = = = 0,9030 (4)

Accuracy = = = 0,9451 (5)

TABLE I
Accuracy Value, sensitivity, specificity, ppv dan npv neural network method

neural network %	
Accuracy	94,51
Sensitivity	91,40
Specificity	98,33
PPV	98,53
NPV	90,30

2. ROC Curve Evaluation
The area under curve estimates the probability of output from a randomly selected sample from a positive or negative population, the larger the AUC, the better the classification is used. From figure 2 there is a ROC graph with value of AUC (Area Under Curve) equal to 0,961 with diagnosis result Excellent classification.

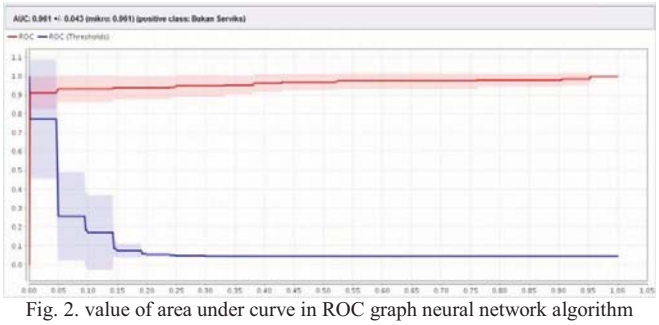


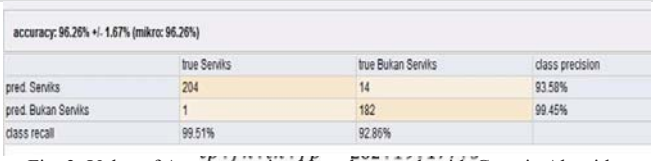
Fig. 2. value of area under curve in ROC graph neural network algorithm

B. Test results using neural network method with Genetic Algorithm

The measurement of accuracy and AUC (Area Under Curve) of the model testing that has been done:

1. Confusion Matrix

Evaluation of the classification model is based on testing to estimate the right and wrong objects. 401 resulted in training data obtained as follows:



accuracy: 96.26% +/- 1.67% (mikro: 96.26%)			
	true Serviks	true Bukan Serviks	class precision
pred. Serviks	204	14	93.58%
pred. Bukan Serviks	1	182	99.45%
class recall	99.51%	92.86%	

Fig. 3. Value of Accuracy using Neural network with Genetic Algorithm

In the figure of confusion matrix can be seen there are 204 cases classified correctly as the cervix (tp) of a total of 401 cases, there is 1 case wrong misclassification that should not be cervix but predicted cervix (fp). Next there are 182 cases classified correctly instead of cervix (tn), and 14 cases are classified incorrectly that should be cervical predicted not cervix (fn). Level accuracy using genetic algorithm based neural network algorithm is 96.26%, and can be calculated to find accuracy, sensitivity, specificity, ppv and npv results in the following equation:

$$Sensitivity = \frac{tp}{tp+fn} = \frac{204}{204+14} = 0{,}9357 \quad (1)$$

$$Specificity = \frac{tn}{tn+fp} = \frac{182}{182+1} = 0{,}9945 \quad (2)$$

$$PPV = \frac{tp}{tp+fp} = \frac{204}{204+1} = 0{,}9951 \quad (3)$$

$$Accuracy = \frac{tp+tn}{tp+fn+tn+fp} = \frac{204+182}{204+14+182+1} = 0{,}9625 \quad (4)$$

$$NPV = \frac{tn}{tn+fn} = \frac{182}{182+14} 0{,}9285 \quad (5)$$

TABLE II
Accuracy Value, sensitivity, specificity, ppv dan npv neural network method with Genetic Algorithm

Neural network (%)		*Neural network +GA* (%)	
Accuracy	94,51	*Accuracy*	96,25
Sensitivity	91,40	*Sensitivity*	93,57
Specificity	98,33	*Specificity*	99,45
PPV	98,53	PPV	99,51
Npv	90,30	Npv	92,85

2. ROC Curve Evaluation

Area Under Curve (AUC) estimates the probability of output from a randomly selected sample of a positive or negative population, the larger the AUC, the better the classification is used. Figure 4 are comparison graphic between neural network with genetic algorithm and neural network:

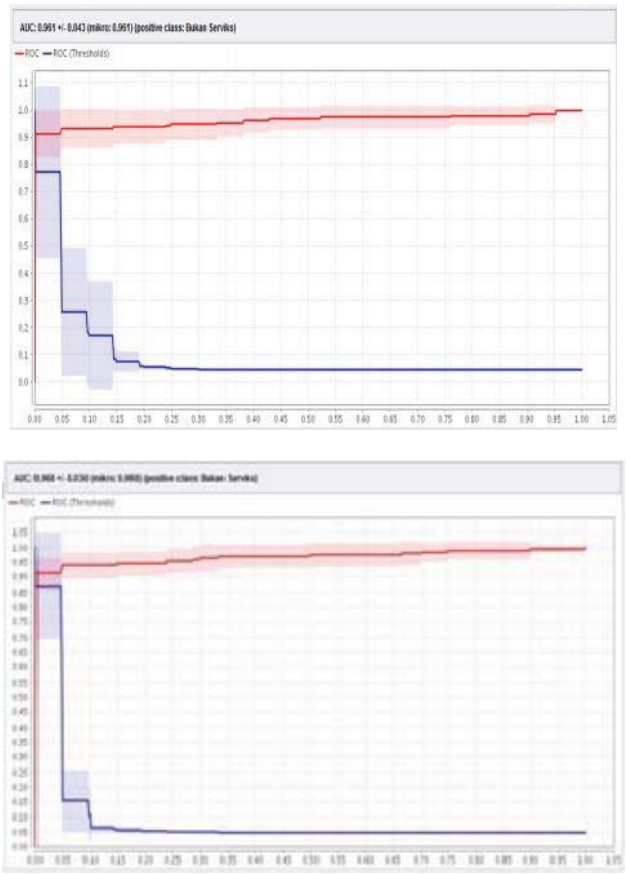


Fig. 4. Comparison of ROC Curve Neural Network and Neural Network with Genetic Algorithm

The Figure 4 shows the ratio of ROC curve between neural network and neural network based on genetic algorithm with area under curve value 0.961 for neural network and 0.968 for neural network based on genetic algorithm where the diagnosis result Excellent classification.

C. Evaluation Analysis and Validation Model

RapidMiner measurement evaluation is to compare the value of accuracy, precision value, and recall value between neural network algorithm with neural network algorithm based on genetic algorithm. Data measurements were performed with confusion matrix and ROC Curve (Area Under Curve) to evaluate the results of both algorithms. Classification methods can be evaluated based on their level of accuracy, speed, reliability, and interpretability[23]. The classification evaluation is based on testing on true and false objects[24] . The accuracy value for the neural network algorithm model is 94.51% and the accuracy value for the GA-based neural network model is increased to 96.26% with the difference of 1.75% accuracy can be seen in table 3 below:

TABLE III
Testing of neural network with genetic algorithm

	Neural network	*Neural network +GA*
Accuracy	94,51%	96,26%
auc	0,961	0,968

In the calculation of area under curve value obtained for 0.961. so the classification of the accuracy of the diagnostic tests included in the category is very good, while for the neural network algorithm with genetic algorithm produce value of 0.968 and the diagnosis value is Excellent classification, and the difference of both of 0.07 can be seen in table 3.

D. Algorithm Implementation using graphical user interface

Based on the testing results of Cross Validation, Confusion matrix and ROC Curve, then the algorithm is applied in graphical user interface to provide a decision about the prediction of cervical cancer.

Fig. 5. Cervical Cancer Prediction Application

V. CONCLUSION

In this research, we tested the model using neural network with genetic algorithm to predict cervical cancer. Several experiments were conducted to obtain optimal architecture and produce more accurate prediction accuracy. Experimental results with various combinations of research parameters showed that experiments using neural network obtained the best accuracy value is 94.51% with value of under curve area 0.961. While experiment with using neural network based on genetic algorithm got 96.26% accuracy value with value area under curve 0.968. The results show that the model formed by the neural network based on genetic algorithm produces better accuracy compared to neural network without genetic algorithm.

Based on the tests that have been done can be concluded that the genetic algorithm can improve neural network performance in predicting data of cervical cancer.

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