Performance Evaluation Of Artificial Neural Network Classifiers For Predicting Cesarean Sections

Suwarno, Paulus AlukFajarDwi Santo

Abstract: Caesarean section or commonly called cesarean section is laborartificial, where the fetus is born through an incision in the abdominal wall and uterine wall with the condition that the uterus is intact and the fetus weighs above 2500 grams. Cesarean section cannot be performed if there is no agreement from the patient or family members regarding the surgery. In recent years, the use of machine learning in predicting disease has increased rapidly. One classification technique used in machine learning is artificial neural networks. In this study, we used backpropagation neural networks to predict cesarean section. This study uses a dataset sourced from the UCI Machine Learning Repository. This dataset contains information about the results of the cesarean section of 80 pregnant women with essential characteristics of labor problems in the medical field. Model evaluation is performed using accuracy, sensitivity, and specificity values. The area under curves (AUC) and ROC curves are used to calculate performance evaluations. Based on experimental results, research shows that backpropagation neural networks can be used as an alternative model in determining the cesarean section.

Index Terms: Artificial Neural Network, Cesarean, Classifiers, Performance Evaluation

1. INTRODUCTION

This increasingly advanced era is a lot of inventions and innovations made by humans in various fields in order to improve the ability and facilitate humans. One of these innovations occurred in the medical field.One of the birthing processes has now started to develop into various types. One of the most birthing processes widely used to help babies and mothers who give birth is the process of giving birth "Cesar" also called cesarean section is surgical delivery where the incision is carried out in the mother's abdomen (laparotomy) and uterus (hysterotomy) to expel the baby. Cesarean section is generally done during labor through the vagina is not possible because it is risky to other medical complications[1]. The issuance of the Law on Medical Practice in 2004, which states that patients have three rights in their treatment can then be the first framework in this case analysis. First, the patient has the right to choice of treatment on him. This statement confirms that the request for cesarean delivery by the patient is justified. Second, the patient has the right to get an explanation of the medical actions that will be performed on him. This indicates the doctor's obligation to provide a clear explanation to the patient regarding the advantages and disadvantages of the actions and risks faced during surgery and the future. Finally, the patient has the right to refuse medical treatment on him; in this case, the patient is justified to reject the recommendation of vaginal delivery given by a doctor [2].In response to these conditions, it is necessary to detect efforts early in the cesarean section so that in the future, no other medical complications will occur. An artificial neural network is one of the mathematical models that can be applied in diagnosing medical diseases by recognizing the pattern of symptoms. Artificial neural networks were first introduced in 1940. Neurophysiologists Warren McCulloch and mathematician Walter Pits designed the first mathematical implementation of an artificial neuron that combines the foundations of neuroscience with mathematical operations [3]. In recent years, artificial neural networks have been proposed as an alternative tool for classification. Also, artificial neural networks can also be used for pattern recognition, studying data, and making predictions.
Several studies of disease detection using artificial neural networks include detection of breast cancer, detection of solar radiation, weather forecasting, facial recognition, and writing recognition. Also, machine learning techniques can also be used to help doctors diagnose patients, especially in cases when results are difficult to predict and choose the best surgical method [4]. In this study, artificial neural networks are used to design and analyze diabetes detection systems. The backpropagation algorithm is used to design the system. The diagnostic performance of artificial neural network systems is evaluated using Receiver Operating Characteristic (ROC) analysis to determine the level of accuracy, sensitivity, and specificity.

- *Primary Teacher Education Department, Faculty of Humanities, Bina Nusantara University, Jakarta, Indonesia 11480. E-mail: suwarno2@binus.edu*
- *Business Law Program, Law Department, Faculty of Humanities, Bina Nusantara University, Jakarta, Indonesia 11480. E-mail: paulus_afds@binus.edu*

2 METHOD

2.1 Dataset

The data in this study were obtained from the UCI Machine Learning Repository. This dataset contains information about the results of the cesarean section of 80 pregnant women with essential characteristics of labor problems in the medical field. Five attributes were chosen to predict cesarean decisions. These five attributes include age, number of pregnant, delivery time, blood pressure, and heart status [5]. These attributes are classified in Table 1.

TABLE 1

ATTRIBUTES CLASSIFICATION

Attributes		Classification
Age	Input 1	Numerical (17 ≤ Age ≤ 40)
No. of Pregnant	Input 2	Numerical (1, 2, 3, 4)
Delivery Time	Input 3	0 = Timely , 1 = Premature , 2 = Latecomer
Blood Pressure	Input 4	0 = Low , 1 = Normal , 2 = High
Heart Status	Input 5	0 = Apt, 1 = Inept
Caesarian	Output	0 = No, 1 = Yes

2.2 Artificial Neural Network

An artificial neural network model was designedfollowing several systematic procedures.The steps in preparing the model include collecting data, preprocessing data, build networks, train networks, and test performance of artificial neural network models. In this study, artificial neural network models are the multilayer perceptron model is used with five neurons in the input layer, nine neurons in the hidden layer, and one neuron in the output layer.Backpropagation is a multilayer perceptron neural network model. The multilayer perceptron is an artificial neural network with many layers that have one or more layers located between the input layer and the output layer (has one or more hidden layers). Artificial neural networks with many layers can solve complex problems compared to a single layer.The backpropagation algorithm is an example of this type of learning and is widely applied to various purposes. The learning process takes place by entering data that will be trained by the network. Information from the input layer is distributed to the hidden layer to process information. Furthermore, the predicted results at the output layer are compared with the values desired for error calculation [6].Artificial neural network training is carried out for weight calculation so that at the end of the optimal training weights will be obtained. During the training process, weights are arranged iteratively to minimize errors that occur[7].

2.3 Model Evaluation

In this study, a trial of an artificial neural network model was performed using Confusion Matrix and Receiver Operating Characteristic Curve (ROC). The Confusion Matrix provides details on misclassification. An artificial neural network model was designedfollowing several systematic procedures.The Confusion Matrix is described in Table 2[8].

TABLE 2

CONFUSION MATRIX

Classification		Predicted Class	
		Class=Yes	Class=No
Observed Class	Class=Yes	True Positive-TP	False Negative-FN
	Class=No	False Positive-FP	True Negative-TN

The accuracy of predictions needs to be done to see the percentage accuracy of artificial neural network systems in predicting patterns. The accuracy of the prediction of artificial neural network models is measured using the following accuracy formula [8].

Accuracy = (TP+TN)/(TP+TN+FP+FN) (1)

In addition, to measure the accuracy of the model, measurements were taken of sensitivity, and specificity as a statistical measure for the performance of binary classifications. Sensitivity measures the proportion of 'true positive' correctly identified, whereas specificity measures the proportion of 'true negative' correctly identified. The sensitivity formula and specificity are as follows [8].

Sensitivity = (TP)/(TP+FN) (2)

Specificity = (TN)/(TN+FP) (3)

Evaluation of the results of artificial neural network prediction is analyzed visually using the Receiver Operating Characteristic Curve (ROC Curve). The ROC graph illustrates the relationship between the observed class and the predicted class. The accuracy of the ROC classification is done by calculating the area under the ROC curve [9]. The accuracy criteria for diagnostic tests using AUC are presented in Table 3[8].

TABLE 3

AUC CRITERIA

AUC	Interpretation
0.90 – 1.00	Excellent Classification
0.80 – 0.90	Good Classification
0.70 – 0.80	Fair Classification
0.60 – 0.70	Poor Classification
0.50 – 0.60	Failure

3 RESULT AND DISCUSSION

In this study, backpropagation neural networks are used to recognize cesarean decision patterns. Artificial neural network systems are designed using Statistica software. In the initial stage, the fault decision data is divided into three parts, namely training data, validation data, and testing data. The training data used in this study were 70% of the data. While testing data as much as 30% of the data. Training data is used to build artificial neural network systems. After the system is formed, then the system is tested using data validation and data testing. Researchers conducted ten experiments to see the average value of accuracy, sensitivity, specificity, and AUC.The results of the calculation of accuracy, sensitivity, and specificity for all experiments are presented in Table 4. Based on Table 4, the average training data values of accuracy, sensitivity, and specificity are 70.18%, 74.45%, and 68.02%. The average data testing the accuracy, sensitivity, and specificity values are 77.50%, 81.97%, and 77.31% while the average validation data of accuracy, sensitivity, and specificity are 74.17%, 80.34%, and 70.50%.

TABLE 4

ACCURACY, SENSITIVITY, AND SPECIFICITY

Evaluation	Exp. 1			Exp. 2		
	Train	Test	Validation	Train	Test	Validation
Accuracy (%)	67.86	75.00	66.67	64.29	75.00	75.00
Sensitivity (%)	74.07	83.33	83.33	68.96	83.33	85.71
Specificity (%)	62.06	66.67	50.00	59.25	66.67	60.00
Evaluation	**Exp. 3**			**Exp. 4**		
	Train	Test	Validation	Train	Test	Validation
Accuracy (%)	64.29	75.00	75.00	85.71	83.33	66.67

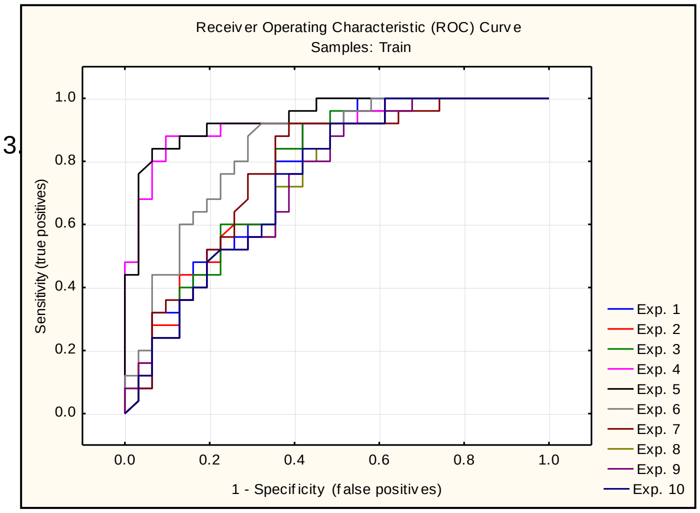
Evaluation	Train	Test	Validation	Train	Test	Validation
Sensitivity (%)	68.96	83.33	85.71	89.65	85.71	75.00
Specificity (%)	59.25	66.67	60.00	81.48	80.00	50.00
Evaluation	Exp. 5			Exp. 6		
	Train	Test	Validation	Train	Test	Validation
Accuracy (%)	85.71	83.33	66.67	78.57	83.33	75.00
Sensitivity (%)	89.65	85.71	75.00	91.30	100.00	85.71
Specificity (%)	81.48	80.00	50.00	69.69	71.42	60.00
Evaluation	Exp. 7			Exp. 8		
	Train	Test	Validation	Train	Test	Validation
Accuracy (%)	69.64	75.00	83.33	64.29	75.00	83.33
Sensitivity (%)	76.92	83.33	87.50	66.67	75.00	80.00
Specificity (%)	63.33	66.67	75.00	60.86	75.00	100.00
Evaluation	Exp. 9			Exp. 10		
	Train	Test	Validation	Train	Test	Validation
Accuracy (%)	60.71	75.00	75.00	60.71	75.00	75.00
Sensitivity (%)	59.18	70.00	72.72	59.18	70.00	72.72
Specificity (%)	71.42	100.00	100.00	71.42	100.00	100.00
Evaluation	Average					
	Train	Test	Validation			
Accuracy (%)	70.18	77.50	74.17			
Sensitivity (%)	74.45	81.97	80.34			
Specificity (%)	68.02	77.31	70.50			

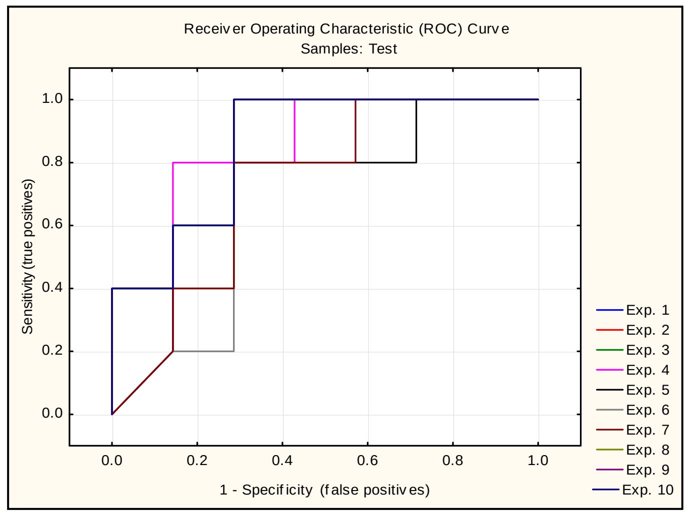
Table 5 shows the AUC values for all experiments. Based on the results, it is known that backpropagation neural networks can recognize patterns well. This conclusion is indicated by the average value of AUC training data, testing data, and validation data covering 0.80, 0.81, and 0.82. All of the average AUC scores are included in the good classification criteria.

TABLE 5
AREA UNDER CURVE

Eval.	Training Data		Testing Data	
	Average	Category	Average	Category
AUC	0.80	Good Classification	0.81	Good Classification
Eval.	Validation Data			
	Average	Category		
AUC	0.82	Good Classification		

Figure 1 *shows the ROC graph for the whole experiment.*





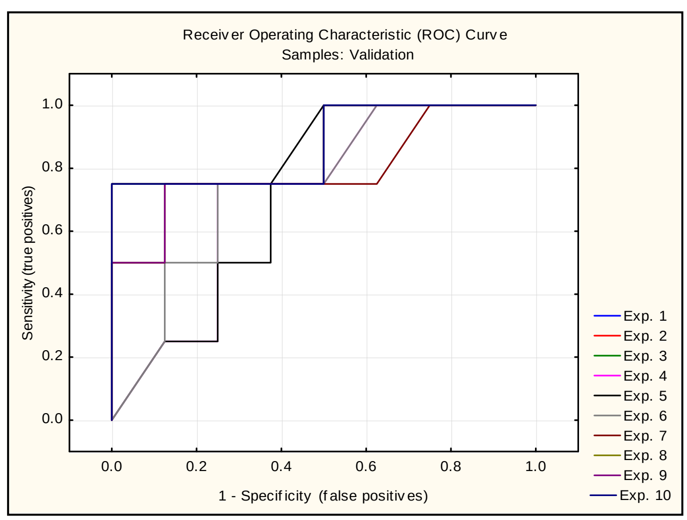


Fig. 1. *Receiver Operating Characteristic Curve*

4 CONCLUSION

Cesarean section prediction is designed using backpropagation neural networks. The artificial neural network model used is a multilayer perceptron model with five neurons in the input layer, nine neurons in the hidden layer, and one neuron in the output layer. The initial stages of the research are dividing the data into three types, namely training data, validation data, and testing data. The diagnostic performance of artificial neural network systems is evaluated using Receiver Operating Characteristic (ROC) analysis to determine the level of accuracy, sensitivity, and specificity. After tenexperiments, the detection of diabetes using backpropagation neural networks resulted in the average training data values of accuracy, sensitivity, and specificity are 70.18%, 74.45%, and 68.02%. The average data testing the accuracy, sensitivity, and specificity values are 77.50%, 81.97%, and 77.31%. While the average validation data of accuracy, sensitivity, and specificity are 74.17%, 80.34%, and 70.50%.Also, AUC training 0.80, AUC testing 0.81, and AUC validation 0.82. Based on the results obtained, classification using backpropagation neural network systems is included in the criteria of good classification. This study shows that backpropagation neural networks can be used as an alternative model in determining the cesarean section.

REFERENCES

[1] Fatimah, Anggraini N., Hendrawati, Dewi, and Aminah. (2017). Pelaksanaan Perjanjian Operasi Bedah Caesar Antara Pasien Dengan Pihak Rumah Sakit Ditinjau Dari Hukum Perjanjian dan Undang-Undang No.29 Tahun 2004 Tentang Praktik Kedokteran (Studi Kasus: Rumah Sakit PKU Muhammadiyah Surakarta). Diponegoro Law Journal, 6(2). Retrieved from http://www.ejournal-s1.undip.ac.id/index.php/dlr/

[2] Sukarya, Wawang, Baharuddin, Mohammad, and Yunizaf. (2017). Sebuah Kajian Etik: Bolehkah Dokter Spesialis Obstetri dan Ginekologi Melakukan Tindakan Sesar Berdasarkan Permintaan Pasien Tanpa Indikasi Obstektrik yang Nyata?. Jurnal Etika Kedokteran Indonesia, 1(1), 7-11. https://doi.org/ 10.26880/jeki.v1i1.3.

[3] Soares, FM & Souza, AMF. (2016). Neural network programming with Java : unleash the power of neural networks by implementing professional Java code (First Edit). United Kingdom: Packt.

[4] Boris Milovic, Milan Milovic. (2012).Prediction and Decision Making in Health Care using Data Mining. International Journal of Public Health Science (IJPHS), 1(2), 69-78.

[5] M.Zain Amin& Amir Ali. (2018). Performance Evaluation of Supervised Machine Learning Classifiers for Predicting Healthcare Operational Decision'.Machine Learning for Operational Decision Making, Wavy Artificial Intelligence Research Foundation, Pakistan.

[6] Sapon, Muhammad A., Ismail, Khadijah, &Zainudin, Suehazlyn. (2011). Prediction of Diabetes by using Artificial Neural Network. International Conference on Circuit, System and Simulation IPCSIT vol.7 (2011) IACSIT Press, Singapore.

[7] Ayodele A., Adebiyi, Charles K., Ayo, Marion O., Adebiyi, & Sunday O., Otokiti. (2012). Stock Price Prediction using Neural Network with Hybridized Market Indicators. Journal of Emerging Trends in Computing and Information Sciences 3(1): 1-9.

[8] Gorunescu, F. (2011). Data mining: concepts and techniques. German: Springer. http://doi.org/10.1007/978-3-642-19721-5

[9] Abdillah, Abdul A. & Suwarno. (2016). Diagnosis of Diabetes Using Support Vector Machines with Radial Basis Function Kernels. International Journal of Technology 5: 849-858.