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Development of Intelligent Applications for Diseases Detection in Pregnant Women

Sri Widodo[1], Anik Sulistiyanti [2], Anton Susanto[3]
[*1,2,3]*Health Science Faculty, Universitas Duta Bangsa Surakarta, Central Java, Indonesia.*
Email: sri_widodo@udb.ac.id

Abstract
The death rate for pregnant women in Indonesia is still very high. Lack of knowledge about the symptoms experienced during pregnancy makes pregnant women ignore certain symptoms which can indicate dangerous diseases and be an indirect cause of death of pregnant women. The risk of maternal death is also higher due to delays in decision making for referral. Based on this, the proposed solution is to develop an intelligent application to diagnose diseases in pregnant women using the Backpropagation Artificial Neural Network method, which can help identify diseases during pregnancy based on the symptoms felt by pregnant women. The method used to develop software to detect pregnant women's illnesses based on their symptoms is the Backpropagation Neural Network method. The application developed is expected to help pregnant women and midwives in recognizing diseases during pregnancy based on the symptoms felt by pregnant women and the referral places that pregnant women should go to. The test results obtained an accuracy value of 70 %.

Keywords: *Backpropagation, regnant Women, Smart Applications*

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I. INTRODUCTION

The mortality rate for pregnant women throughout the world is still very high, this is because pregnant women are very sensitive to various health problems. According to WHO, maternal death is death during pregnancy or within 42 days after the end of pregnancy caused by any cause related to or aggravated by the pregnancy or its management. The Indonesian Ministry of Health (Kemenkes) recorded that the maternal mortality rate in 2022 will be around 183 per 100,000 births. Lack of knowledge regarding the symptoms experienced during pregnancy is a problem that is currently occurring. This makes pregnant women ignore certain symptoms which actually indicate a dangerous disease. Apart from that, the risk of maternal death is also higher due to delays which are an indirect cause of maternal death. The delay in question is a delay in making a decision to refer, including low knowledge of pregnant women about danger signs during pregnancy. From the results of Basic Health Research in 2010, only around 44 percent of pregnant women knew the danger signs [1]. The author's solution that can be used by pregnant women to recognize danger signs is an expert system for diagnosing illnesses in pregnant women. This expert system can help identify diseases during pregnancy based on the symptoms felt by pregnant women and the referral places that patients should go to. Research on expert systems for detecting diseases of pregnant women has been carried out by several researchers, the first of which is research from Brigitta, et al [2] (2010) which uses the forward chaining method to diagnose diseases of pregnant women. This method is applied in the diagnosis process through the symptoms felt by the patient and produces an outcome in the form of the disease suffered by the patient. The percentage accuracy of the forward chaining method in this study was 87%. The second research is research from Aryu. The research carried out was to create an expert system for diagnosing diseases in pregnant women using the Certanty Factor (CF) method which can help identify diseases during pregnancy based on the symptoms felt by pregnant women and the referral places that patients should go to. The CF method has system performance that is able to run according to functional requirements and results in a high percentage of accuracy. Apart from that, the CF method can describe the level of confidence of an expert regarding the problem being faced. Based on the test results, it was obtained that 100% of the functionality of the expert system for diagnosing pregnant women's diseases runs in accordance with the list of system requirements and the system has an accuracy level of 100%.

The next research is research from Pratama. The research carried out was to create an Android-based expert system application, using the forward chaining method. This application was created as a guide and information about pregnancy diseases. This application was created as an alternative to consulting or checking with a gynecologist or midwife. This application was created using Android Studio, JDK, SDK, Adobe Photoshop, StarUML, and DIA software. This application can run as desired. The test results show that 96% of

experts agree that this application can identify diseases based on the symptoms selected by the user and display appropriate solutions [3].

The research carried out by Hatta is to build a web-based expert system (ES), such as doctors or patients to diagnose pregnancy anywhere, so that it can help women find out the symptoms of pregnancy disorders. ES was analyzed using the forward chaining (FC) method and Bayesian theorem. One of the techniques that has been used is to create a decision tree, then a search is carried out using FC and probability calculations using Bayesian. Based on the selected input symptom dataset used by 35 patients, the results of pregnancy disorders have the highest risk of eclampsia, with a system suitability value of 97% and system accuracy of 82.86%. In further research, we carried out a hybrid of Bayesian Theorem and FC with a fuzzy-neural network environment to produce higher accuracy and accuracy values which will also make decisions in group clinical outcomes [4].

Another research on intelligent systems for detecting pregnant women's diseases is research from Pratama [5], Sari [6], Wati [7]. From the description above, it can be seen that all methods used to detect disease in pregnant women mostly use Certanty Factor, while detection using Backpropagation is still rarely done by researchers. The research carried out was to develop a smart application for detecting pregnant women's diseases based on artificial intelligence as a diagnostic tool. The intelligent system used is Backpropagation Artificial Neural Network (ANN). The backpropagation algorithm was developed with the addition of momentum. Momentum in a neural network is a change in weight based on the gradient direction of the last pattern and the previous pattern. The addition of momentum parameters to the Artificial Neural Network aims to speed up the learning process towards convergence. Experimental results have also shown that this method can make the network converge quickly and stably. This is because momentum allows the network to adjust weights drastically as long as the adjustment results in the same direction across multiple patterns. So, training becomes faster. This backpropagation With Momentum algorithm is the contribution and novelty of the proposed research. The application developed is expected to help pregnant women and midwives in recognizing diseases during pregnancy based on the symptoms felt by pregnant women.

II. MATERIALS

The data used in the intelligent maternal disease detection system comes from Posyandu Sejahtera, Ponowaren Village, Tawangsari, Sukoharjo, Central Java, Indonesia. The data used includes data on diseases in pregnant women, including: Hyperemesis Gravidarum, Miscarriage, Anemia, Preeclampsia, and HELLP syndrome [8], [9]. Apart from that, data on symptoms in pregnant women include: nausea, vomiting, dehydration, difficulty eating and drinking, vaginal bleeding, stomach cramps, weakness, fever, fatigue, dizziness, difficulty concentrating, pale skin, shortness of breath, hypertension, gynecology. protein in the urine, headaches, blurred vision and pain in the pit of the stomach [10]. The data used in this research can be divided into two. The first is the data used as training data. This data is the data that will be used in the classification process. Second is the data used in the testing process. This data is data from examination results of pregnant women.

III. METHODS

The stages in developing a smart application for detecting pregnant women's disease based on Artificial Intelligence [11] can be explained in Figure 1.

3.1. Creating User Interface

Creating a user interface aims to make it easier for users to operate the software being developed.

3.2. Data Collection

The step in data collection is a step to analyze, design and build an artificial neural network system. The data collected in this research is secondary data from the Community Health Center or Posyandu. The secondary data used in this research has been validated by hospital doctors or midwives.

3.3. Analysis Stages

The analysis stage is the stage for analyzing the data needed for the training and testing stages in Backpropagation, as well as analyzing the needs for building applications, thereby simplifying the application design process. Data analysis carried out includes input data and data transformation. Based on interviews with resource persons, rules were obtained that link pregnant women's illnesses with symptoms or complaints experienced by pregnant women. The rules contain 5 diseases and 18 symptoms. The following is a table of data on diseases of pregnant women which can be seen in Table 1.

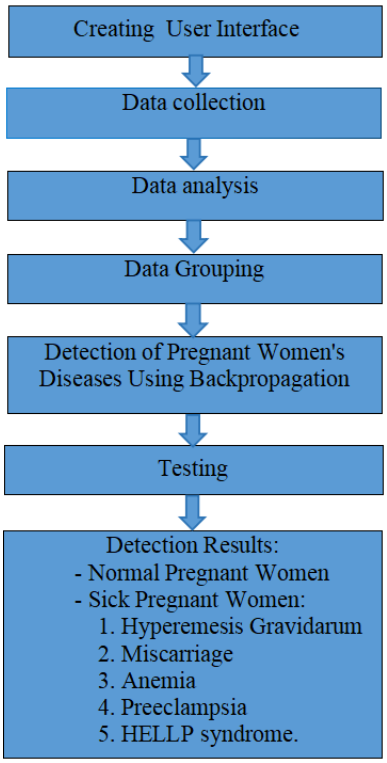

Figure 1: Steps of the Proposed Method

Table 1: Types of diseases in pregnant women

Disease Codes	Disease Names
D001	Hyperemesis Gravidarum
D002	Miscarriage
D003	Anemia
D004	Preeclampsia
D005	HELLP syndrome

Table 2 contains the symptoms or complaints experienced by pregnant women.

Table 2: Symptoms in pregnant women

Symptom Codes	Symptom Names
S001	Nausea and dizziness
S002	quite severe vomiting
S003	dehydration
S004	difficult to eat or drink
S005	vaginal bleeding
S006	stomach cramps or pain?
S007	body feels weak
S008	fever
S009	tired
S010	dizzy
S011	difficult to concentrate
S012	pale skin
S013	hard to breathe
S014	high blood pressure (hypertension)
S015	urine contains protein
S016	severe headache
S017	visual impairment
S018	heartburn

To make it easier to process backpropagation, a table of the relationship between disease and symptoms was created, as shown in table 3.

Table 3: Relationship between disease and symptoms

Symptoms	Diseases				
	P001	P002	P003	P004	P005
S001	X				X
S002	X				X
S003	X				
S004	X				
S005		X			
S006		X			
S007		X	X	X	
S008		X			
S009			X		X
S010			X	X	
S011			X		
S012			X		
S013			X		
S014				X	
S015				X	
S016				X	X
S017				X	
S018				X	X

The method used to detect disease in pregnant women is backpropagation. This technique uses a multi-layer network with the aim of minimizing errors[12]. The input data is in the form of symptoms of pregnant women's illnesses, while data transformation is the stage for changing the symptom data values into a scale of numbers 0 and 1 so that they can be used for calculations in the training and testing stages in Backpropagation.

3.4. Data Grouping

The data grouping stage is the stage for dividing the data into training data and test data. The data division stage is 70%, 80%, 90% training data and 30%, 20%, 10% test data. From the overall data of pregnant women.

3.5. Detection of Pregnant Women's Disease Using Backpropagation

In the initial stage, the system training process is carried out using existing training data so that it can carry out training in accordance with Backpropagation training. After the training process is carried out, the final weight will be obtained. This final weight will later be used to carry out testing. The process of Backpropagation can be explained as follows:

a. Initializing the initial weight with a small random value can be done by choosing a value in the range between 0 and 1. Determine the maximum epoch and learning rate. In this manual calculation example, a maximum epoch of 100 and a learning rate of 0.001 will be used.
b. Enter the training data in the form of input variables (X_1 to X_n) and the target class.
c. The training stage consists of 3 stages, namely feedforward propagation, backpropagation, and changing weights and bias by adding momentum parameters. Carry out the calculation process at these three stages.
d. Carry out the training process for the maximum number of epochs that have been determined.
e. The final weight obtained from the training process will then be saved for use in the testing stage.

The Artificial Neural Network Architecture using the Backpropagation Algorithm [13] built in this research can be seen in Figure 2.

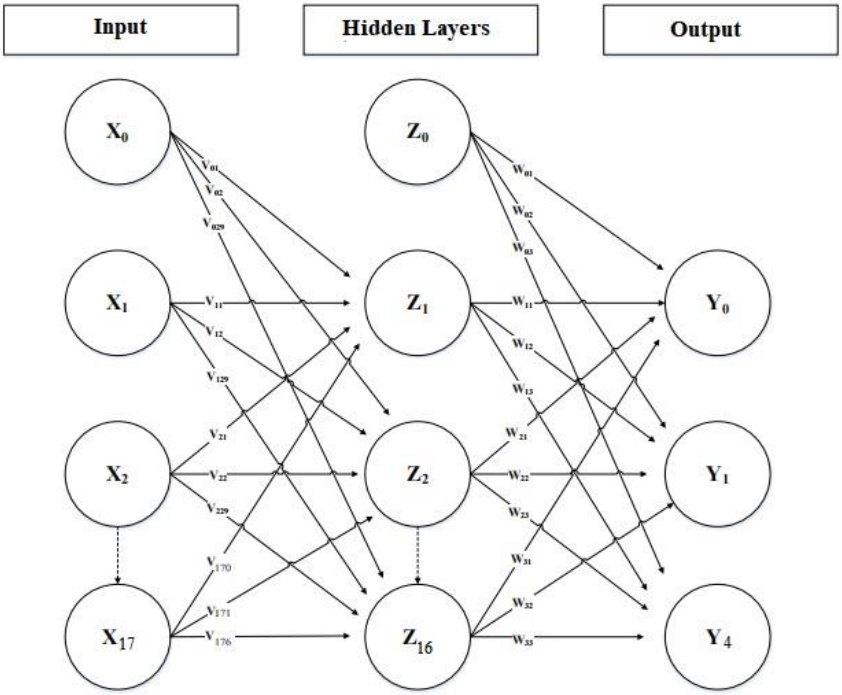

Figure 2: Backpropagation Neural Network Architecture

Where X_0 to X_{17} = input node in the input layer, Z_1 to Z_{16} = hidden node (hidden layer) and Y = output node

3.6. Testing

At this stage, testing will be carried out on the system using the data provided. This stage aims to find out whether the output produced is in accordance with the actual data. From several Artificial Neural Network model architecture tests that have been carried out by entering different parameters for learning rate, goal and amount of data. To determine the best artificial neural network model architecture that will be used in detecting diseases of pregnant women, in this study the criteria are that the best architecture is the one that has smaalest the Root Mean Square Error (RMSE), with goal discovery in the fastest epochs (smallest value) and has performance for the smallest error rate (performance).

3.7. Calculating Accuracy, Sensitivity and Specificity

To test the accuracy of the proposed method using the Receiver Of Characteristic (ROC) method. By comparing the classification results of the system developed with the detection results of experts (doctors or midwives). The classification results will be compared with ground truth (health center midwives) using the Receiver of Characteristic (ROC) method, so that four values will be obtained, each of which are true positive, false negative, false positive and true negative. True positive (TP) indicates a normal status that is correctly identified according to its class. False positive (FP) is a normal status that should have been identified correctly in its class but in the classification process it was identified incorrectly. True negative (TN) is an abnormal status that is identified as normal. False negative (FN) indicates an abnormal status that is identified as a member of the abnormal class. Based on these four values, the true positive rate (TPR) value is obtained which is known as sensitivity.

IV. RESULT AND DISCUSSION

Before using the application developed, the user must first carry out training on the training data used. The training menu is a display for carrying out the training process and a display for entering the values of the maximum epoch variables, target error, learning rate, number of hidden layer neurons and momentum. The training display design can be seen in Figure 3 below:

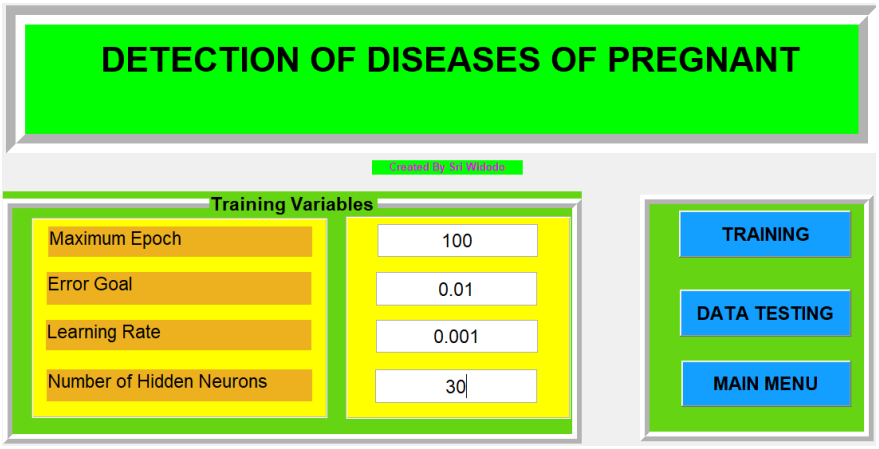

Figure 3: Training Menu

The test display is a display for carrying out the testing process and displays the test data table and test results table and there is a button for carrying out accuracy testing using the confusion matrix. The testing menu can be seen in Figure 4 below:

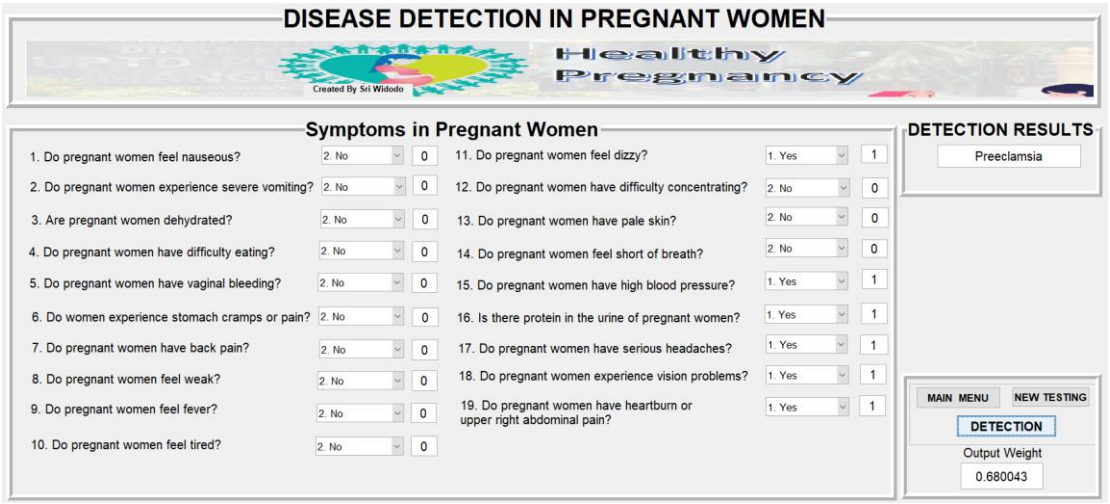

Figure 4: Disease detection menu for pregnant women

The parameter to measure the success rate of the model is the accuracy value. Accuracy values can be determined by carrying out tests using testing data. The test was carried out four times. The first to fourth tests used training data of 60:40, 70:30, 80:20 and 90:10 respectively, with a learning rate of 0.001, maximum epoch 100. Target error 0.01 and number of hidden layer neurons 8. The backpropagation algorithm can carry out a prediction process, but the resulting value is greatly influenced by determining the parameters of the learning rate and the number of neurons in the hidden layer. There are factors that influence the level of correctness of predictions in a backpropagation neural network, namely learning rate, target error, amount of learning data and weight values assigned randomly to each neuron. A decrease in the learning rate will make the learning process slower.

V. CONCLUSION

The conclusion that can be drawn from this research is that the expert system using the backpropagation method with momentum can work quite well with valid results of around 70% or as many as 11 patients out of the 16 patients who have been selected. This can be a means for midwives to see the patient's history of complaints, so that they can provide solutions and appropriate initial treatment to prevent maternal and infant deaths before the birth process. For further research, additional symptoms and diseases can be carried out, it can also be carried out using other methods that are more current and accurate.

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