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Submission date: 03-Jun-2020 09:49PM (UTC+0800)

Submission ID: 1337090647

File name: sing_naive_bayes_classification_model_for_mobile_application.pdf (686.22K)

Word count: 2251

Character count: 12000

PAPER · OPEN ACCESS

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To cite this article: Ewika Nadya Ifitah *et al* 2018 *J. Phys.: Conf. Ser.* **1120** 012049

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The baby delivery method estimation using naïve bayes classification model for mobile application

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Abstract. The maternal mortality rate because of cesarean delivery is still high caused by lack of knowledge of pregnant women about the high risk of pregnancy. Cesarean delivery is an alternative labor but remains at high risk for both mother and fetus. The awareness of the mother to check her pregnancy early and precisely is very important. To support the awareness attitude of pregnant women to their health, so in this research has made an application program for the mobile application based on Android by using Naïve Bayes classification model to predict early childbirth process that will be undertaken. From this research, it can be concluded that the application of the baby delivery method estimation with Naïve Bayes model based on Android can educate pregnant women about high-risk pregnancy condition and prediction of delivery method that will be done with 90% accuracy, 100% sensitivity, and 80% specificity.

1. Introduction

One of the highest maternal mortality rates is due to labor [1]. The most common method of delivery is normal delivery and alternative labor, namely cesarean delivery. WHO has set the average standard of cesarean delivery in a country is 5-15% per 1000 births in the world [2]. Although cesarean delivery is an alternative labor when giving birth has difficulty it does not mean that it is not risky for the mother and fetus, because the risk of death is 25 times greater than normal delivery with a risk of infection 80 times higher and risk of respiratory distress for the fetus [3].

Current cesarean delivery seems more liberal but still with certain medical reasons and indications [4]. This is related to the mother's knowledge of high-risk pregnancies that are still lacking, whereas according to the 2004 Ministry of Justice a pregnant woman should have knowledge about it so that she can think and determine the right attitude, behave to prevent, avoid or anticipate the risk of pregnancy. keep pregnancy and childbirth going well and safely [5].

This is supported by the existence of expert system technology as a decision support system [6]. In the study of SohanaSaiyed et al. using Naïve Bayes to analyze and predict heart disease. Also attached to the pros and cons and the Naïve Bayes application that supports to be used as a prediction system. Collection of data from heart disease patients was analyzed using several data mining techniques to determine the best method, and obtained the highest value of Naïve Bayes accuracy [7]. Mario W.L. Moreira et al. also conducts research on the performance of the Naïve Bayes Classifier (NBC) to create a pregnancy care system. Using data mining this study analyzed pregnancy complications

leading to mortality mainly caused by hypertension (pre-eclampsia). The researcher also compared the NBC performance with several other data mining techniques, with the best result is NBC [8].

Therefore a system is needed to educate mothers about the dangers of cesarean delivery due to high risk pregnancy. This paper combines information technology and expert systems based on Android as a method of predicting the method of delivery that will be undertaken and can be consulted immediately by a doctor.

2. Study method

Cesarean delivery in obstetric science describes a surgical procedure that aims to give birth to a baby by opening the abdominal wall and the mother's uterus [9]. The act of cesarean delivery is performed when there are certain medical indications [10]. There are 17 medical indications used as input systems in this study which include the condition of pregnancy history and current pregnancy.

Based on [4] indications or medical reasons that require cesarean section are indicative of prophylaxis as in women who have heart, lung, kidney, high blood pressure or pre-eclampsia / eclampsia, vital indications such as uterine rupture, bleeding during pregnancy, narrow pelvis, abnormalities of the fetus, and long labor. Whereas indications on the fetus such as fetal distress, fetal death in utero, umbilical cord umbilical, and rare but fatal indications are embolic complications of amniotic fluid that can occur during surgery.

The expert system method used for the prediction system is the Naïve Bayes Classifier. The Naïve Bayes Classifier is a simple probabilistic classification that calculates a set of probabilities by adding up the frequency and combination of values from a given dataset. The algorithm uses Bayes theorem and assumes that all independent or non-dependent attributes are given by values in class variables [11]. Based on [8] Bayes equation as a classifying method is as follows:

$$V_{MAP} = \underset{v \in V}{\operatorname{argmax}} \frac{P(x_1, \dots, x_n | V_j) P(V_j)}{P(x_1, \dots, x_n)} \quad (1)$$

V_{MAP} is the maximum condition of posterior probability to produce a better predictive value in the data set. This method requires training data with limited assumption of size. $P(x_1, \dots, x_n | V_j)$ which is the probability of each parameter under certain conditions, and $P(V_j)$ is the probability of the condition in the whole data. Rapid technological development can be used to build a prediction application system on the mobile device operating system, Android, which has reached all levels of society. Here is the flow of this research method:

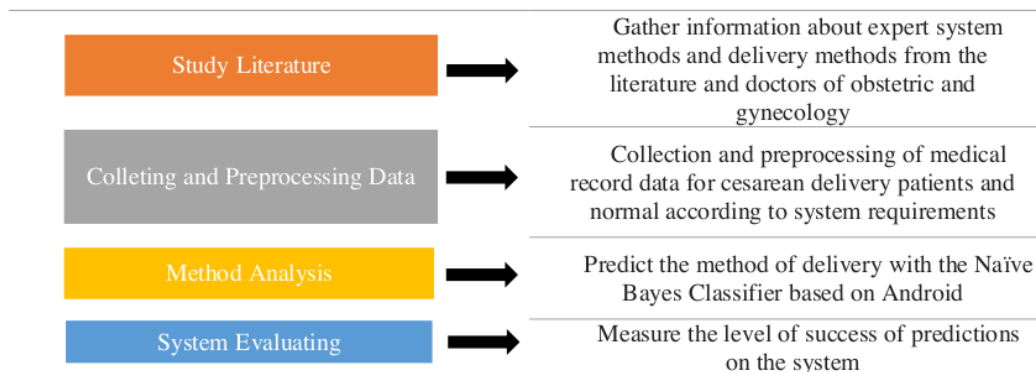


Figure 1. Flow of research method

3. Result and discussion

The Naïve Bayes Classifier conducts training and testing stages to make the prediction system capable of having accuracy according to expert diagnosis. A total of 120 data are used with details of 50 training data and 10 testing data for each delivery class (cesarean delivery and normal delivery). Each

data includes information needed, here is information in the form of an indication of cesarean delivery that has been through the preprocessing stage:

Table 1. Indocation of cesarean delivery

Xi	Parameter	Type
1	X Age	$\geq 35^{\text{th}}$ and $< 20^{\text{th}}$ $20^{\text{th}} - 34^{\text{th}}$
2	X Old prime	First Pregnancy pregnancy > 1 times Age of marriage $\geq 10^{\text{th}}$ Age of marriage $< 10^{\text{th}}$
3	X Delivery space	> 120 months First or ≤ 120 months
4	X Parity	No child > 1 child
5	X Abortion history	Yes No
6	X Delivery act history	Yes No
7	X Caesar history	Yes No
8	X Premature pregnancy history	Yes No
9	X Medic disease history	Yes No
10	X Age of pregnancy	> 9 months ≤ 9 months
11	X Twins pregnancy	Yes No
12	X Hydraminon pregnancy	Yes No
13	X Malpresentation	Yes No
14	X Bleeding	Yes No
15	X Pre-eclampsia	Yes No
16	X Height	≤ 145 cm > 145 cm 5
17	X Body Mass Index (BMI)	$> 25 \text{ kg/m}^2$ dan $< 18.5 \text{ kg/m}^2$ $18.5 \text{ kg/m}^2 - 25 \text{ kg/m}^2$

The first stage in the system (with training data) is to get the probability of both classes of delivery (cesarean delivery (Y1) and normal delivery (Y2)) or called prior class probabilities with the following equation:

$$\begin{aligned}
 P(Y_i) &= \frac{Y_i}{Y} \\
 P(Y_1) &= \frac{50}{100} \\
 P(Y_1) &= 0.5
 \end{aligned}
 \tag{2}$$

Where Y_i is the amount of delivery classes and Y is the total number of data. Then get the Likelihood value which is the result of the multiplication of all the probabilities of each type of parameter in both classes using the following equation:

$$\begin{aligned} P(X_k|Y_i) &= \frac{X_k}{Y_i} \\ P(X_k|Y_1) &= \frac{20}{50} \\ P(X_k|Y_1) &= 0.4 \end{aligned} \tag{3}$$

With X_k the parameter X_1 to X_{17} in each Y_i class, the Likelihood value is obtained by the following equation:

$$\begin{aligned} P(X_k|Y_i) &= \prod_1^k P(X_k|Y_i) \\ P(X_k|Y_i) &= P(X_1, \dots, X_{17}|Y_i) \\ P(X_k|Y_1) &= 2.46 \times 10^{-5} \end{aligned} \tag{4}$$

So that overall after obtaining the calculation results from the above equation for each class, the posterior probability is obtained as in the following equation:

$$\begin{aligned} \text{Probabilitas posterior} &= \frac{\text{likelihood.class prior}}{\text{predictor prior}} \\ P(Y_i|X_k) &= \frac{P(X_k|Y_i) P(Y_i)}{P(X_k)} \end{aligned} \tag{5}$$

Variable $P(X_k)$ can be ignored because it is considered constant where the value will depend on the value of $P(Y_i)$ so that the above equation can be written as:

$$\begin{aligned} P(Y_i|X_k) &= P(X_k|Y_i) P(Y_i) \\ P(Y_1|X_k) &= 2.46 \times 10^{-5} \times 0.5 \\ P(Y_1|X_k) &= 1.23 \times 10^{-5} \end{aligned} \tag{6}$$

Furthermore, to determine the predicted results, the posterior probability value of the cesarean delivery class (Y_1) and normal delivery (Y_2) will be compared as equation below:

$$\begin{aligned} P(X_k|Y_1)P(Y_1) &> P(X_k|Y_2)P(Y_2), i \neq j \\ 1,23 \times 10^{-5} &> 6,9 \times 10^{-8} \end{aligned} \tag{7}$$

From this equation shows when the value of the posterior probability of one class is higher than that value will be the result of the system prediction.

To determine the performance of the system it needs to testing using 20 data test data. The test performed by test the suitability of the results of prediction of the application with the reality of the delivery process that the patient undergoes. Data testing also consists of 10 cesarean delivery data and 10 normal delivery data. From the test obtained accuracy of 90% which means there is an error value of 10%. With accuracy for cesarean delivery class (sensitivity) is 100%, and the accuracy of normal delivery class (specificity) 80%. It's possible when the system database tends to suitability with cesarean delivery parameters, so that system knowledge will be sensitive to the appearance of cesarean delivery parameters.

4. Conclusion and Suggestion

The application of the expert system of the Naïve Bayes Classifier to predict the method of delivery has been made with an accuracy of 90%, so that it is expected to educate pregnant women about the condition of high-risk pregnancy and the predictions of the method of delivery. The application of delivery method prediction can still be developed to provide the education of high risk pregnancy and better predictive result for the pregnant woman by improve the data base and developing application as a predictive delivery method at regular interval in each trimester.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6
