

# Implementation of Bayes Network in Giving First Aid Solution

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**Abstract**— In a critical situation, such as traffic accident, sometimes a person is required to do a first aid in order to save someone's life, until the emergency unit arrives. If a person does not know how to do a first aid, he or she will need a guide, such as an application in a device that people always bring, a smartphone. Technology is one of the science fields that grow very fast. It is not only about the hardware but also the software, such as artificial intelligence. Artificial intelligence is one of the fields that are commonly used nowadays, either for gaming purpose, education and research purpose, or other purposes. This application, ES First Aid, is an Android application to help the user to decide what to do in emergency situation. It will ask a few questions related to the condition of the casualty then it will tell the user clearly about the actions needed to be taken.

**Keywords**— bayes network, first aid, traffic accident, smartphone

## I. INTRODUCTION

Safety is our highest priority in almost every aspect of our life. Ignoring safety will result in life threatening situation. Therefore, people make some rules in order to avoid accidents or any other life threatening situation. For example, when driving a car we must follow every rules on the road, such as speed limit, traffic lights, and traffic signs. Ignoring these rules might cause accidents. But sometimes an accident is not avoidable, even when we already follow every single rules and safety guides. When accident happens, some first aid actions may be needed in order to save lives. In this kind of situation, a quick guide of first aid is required for people who do not know or do not understand about it.

Technology is one of the science fields that grow very fast. One of the subject field covered is expert system, as a part of artificial intelligence. With expert system, a computer can identify problems and give solutions quickly like a human expert. This is very useful in a critical situation such as traffic accident. Nowadays, almost everyone has a smartphone. There are a few types of smartphone based on the operating system used, and Android is one of the most commonly

used. Some Android smartphones' price is relatively cheaper than the other type of smartphones, therefore it has a wider market range than the other type of smartphones. Because of the these things, a first aid guide Android application with expert system implemented is required to give a quick guide in life threatening situation.

## II. METHODOLOGY

There are several methods used, in order to develop the application until it is able to show the result and give the related solution.

### II.1 Get User's Answer

In the Identification page, there are 36 questions with two radio buttons for each question (radio button Yes and No). The application needs to get all of the answers first, before begin calculating the probability of each injury and disease.

In order to get the user's answer, the application first will put each of the radio group in an array called *rgf [ ]*. Then, for each radio group stored in *rgf [ ]*, the application will look for the id of the selected radio button. The application then will check the text of the radio button with the selected id. If this text equal to "Yes", the application will store "1" in an array called *answer[ ]*. Otherwise, the system will store "0" in *answer[ ]*.

### II.2 Calculate Probability

After the application get all of the user's answer and store it in *answer[ ]*, it will call a function called *calcProb()* to begin calculating the probability. The main purpose of this function is to calculate the probability of each injury and disease based on the symptoms that the user entered. Bayes network provides a probabilistic model for uncertain reasoning by using Bayes theorem formula below [17] [19].

$$P(S|D) = \frac{P(D|S) \times P(S)}{P(D)} \quad (1)$$

D means current disease and S is the symptom. Since the symptom is more than one, S can be replaced with S1, S2, S3, and so on to become the formula 2 below.

$$P(S1, S2, S3|D) = \frac{P(D|S1, S2, S3) \times P(S1, S2, S3)}{P(D)} \quad (2)$$

Next, the  $P(D|S1, S2, S3)$  needs to be separated with the other because what is needed to be calculated is the probability of an injury given several symptoms entered by user. Then, in order to calculate  $P(S1, S2, S3|D)$ , it can be replaced with the formula 3 below.

$$P(S1, S2, S3|D) = P(S1|D) \times P(S2|D) \times P(S3|D) \quad (3)$$

After the  $P(S1, S2, S3|D)$  in formula 1 is replaced with the formula 3, the whole formula will be as shown below.

$$P(D|S1, S2, S3) = \frac{P(S1|D) \times P(S2|D) \times P(S3|D) \times P(D)}{P(S1, S2, S3)} \quad (4)$$

The formula 4 above can be used to calculate the probability of every disease given several symptoms. The  $P(S1, S2, S3)$  in formula 4 does not need to be calculated and can be ignore. This happens because the value of  $P(S1, S2, S3)$  will always have the same value for every diseases.

Next, in order to calculate  $P(S1|D)$ , the formula 5 below can be used to calculate it.

$$P(S1|D) = \frac{P(S1 \cap D)}{P(D)} \quad (5)$$

The formula 5 above can be simplified by using several steps. The  $P(S1 \cap D)$  can be replaced with  $\frac{n(S1 \cap D)}{n(cases)}$  and  $P(D)$  can be replaced with

$\frac{n(D)}{n(cases)}$ . Then, the formula will be as shown

below in formula 6.

$$P(S1|D) = \frac{\frac{n(S1 \cap D)}{n(cases)}}{\frac{n(D)}{n(cases)}} \quad (6)$$

$n(S1 \cap D)$  means the number people that has injury D with symptom S1.  $n(cases)$  is the total number of people in the database.  $n(D)$  is the total number of people with injury D. The formula in formula 6 can be simplified by eliminating  $n(cases)$ .

Before calculate the probability, the application will get the symptom of each injury and disease from the database. Since this symptom is in

form of string, the application need to substring the id and the number of case, then store it in some variables.

Next, the system will match the symptoms of each injury and disease with user's answers. There are 4 conditions to be considered when matching user's answer and the symptoms. Here is the explanation. For example, the injury "D1" has symptom "S1", "S2", and "S3". If user's answer is "Yes" for either symptom "S1", "S2" or "S3", the system will calculate the probability of injury "D1" and multiply it with user's answer. If user's answer is "No" for either "S1", "S2" or "S3", the system will multiply current probability with user's answer, that is 0 (zero). This happens because current injury is not valid anymore, or in other words, current injury does not match with what the user wants. If user's answer is "Yes" for any symptoms except "S1", "S2", and "S3", the system will multiply current probability with 0 (zero). This happens because the probability of current symptom intersect with current injury is 0 (zero). If user's answer is "No" for any symptoms except "S1", "S2", and "S3", the system will do nothing.

### II.3 Find Maximum Probability

The process of finding the maximum probability happens in a function called *findMax()*. This function will return an integer value called max to indicate which injury has the highest probability value.

The idea of this function is comparing each probability stored in a variable called *prob[ ]*. The index of current maximum probability is stored in a variable called *curMax*. If current probability is greater than the probability with index *curMax*, the application will set *curMax* to current index. After 36 loops, the system then will return the value of *curMax*. If all of the probability is 0 (zero), a boolean variable called valid will remain false. It means the user enter incorrect symptom so the application cannot identify it.

### II.3 Show Solution

When the user clicks the See Solution button in Identification page, the system will show the related solution for the matching injury or disease. This solution will only be shown by the system if the user already clicked the Check button and the system able to find the matching injury or disease. If the user has not clicked the Check button or the system does not able to find the matching injury or disease, the system will do nothing. The code for this process only involves if-else and some intents to open a new page containing related information.

## III. RESULTS

In order to evaluate the method proposed before and the overall application performance, there are some test scenarios conducted. These test scenarios are divided into three phases. The first one is main page

(Expert System page, Information page, and About page) test scenarios. The second one Identification page test scenarios. And last is List View test scenarios.

The first test scenarios are conducted in Main pages (Expert System page, Information page, and About page) to ensure the movement between these pages work properly and no error. These test are done by swiping the screen and clicks on the navigation tabs at the top of the screen. From several tests conducted, the results of these test scenarios above are as expected.

The second test scenarios are conducted in Identification page. The main purpose of these test scenarios are to evaluate the work of the expert system. These tests are done by entering several inputs and evaluate the results. Table 1 below shows the test scenarios in detail.

TABLE 1  
IDENTIFICATION PAGE EVALUATION

No	Scenario	Expected Result
1	Answer "Yes" for matching symptom	System show the matching injury or disease
2	Answer "Yes" for not matching symptom	System does not able to identify the injury and show the message
3	Answer "No" for matching result	System does not able to identify the injury and show the message

Table 1 above shows the test scenarios in Identification page. As already mentioned above, the main purpose of these test scenarios is to evaluate the expert system part of this application. The first test scenarios are done by answering "Yes" for matching symptom. For example, answering "Yes" for S1, S2, and S3 will give result Heart Attack. Answering "Yes" for S1 and S5 will give result Hanged / Strangled. Answering "Yes" for S15, S35, and S36 will give result Hypothermia. There are 22 (twenty two) injuries and diseases in total, and the test scenarios in Identification page covered them all. From several tests conducted, the results are as expected.

The next test scenarios in Identification page are done by answering "Yes" for not matching symptom. For example, Heart Attack has symptom S1, S2, and S3. The test is done by answering "Yes" for S1, S2, S3, and S4. The expected result is the system does not able to identify and show message "cannot find result". From several tests conducted, the results are as expected.

Another test scenarios in Identification page are done by answering "No" for the matching symptom. For example, Drowned has symptom S1 and S4. The tests are done by answering "No" for either S1 or S4. The expected result is the system does not able to identify and show the message "cannot find result". From several tests conducted, the results are as expected.

The last test scenarios for this application are conducted in Information page and First Aid Action page, especially about the list view. The purpose of these test scenarios is to evaluate the list view in Information page and First Aid Action page. The expected results are the system display a new page related to the list item that is clicked by the user. From several tests conducted, the results are as expected.

#### IV. DISCUSSION

This section will discuss about the method used in this application, especially when the system try to identify the injury or disease based on the symptom. This application used Bayes Network as the method to identify the injury.

A Bayesian belief network (Bayesian network for short) describes the probability distribution governing a set of variables by specifying a set of conditional independence assumptions along with a set of conditional probabilities, as stated by Tom M. Mitchell (1997) in his book Machine Learning. A Bayesian belief network represents the joint probability distribution for a set of variables. Each variable is represented by a node. This variable is a Boolean type variable [8].

Bayes belief network can be used in medical diagnosis model. The problem of medical diagnosis can be stated as follows: given a set of symptoms (clinical data) and signals, or test results (tests performed on the patient), assess pathological situations identifying which diseases justify the particular findings. Bayesian networks provide a probabilistic model for uncertain reasoning, adequate for handling the diagnostic problem, as stated by Isabel Minho and Ana Fred in A User-Friendly Development Tool For Medical Diagnosis Based On Bayesian Networks [7].

There are two types of nodes in the disease diagnosis system, which are disease nodes and symptom nodes. Both disease nodes and symptom nodes are Boolean variables. Disease nodes contain states: 'happen' and 'not happen'. Symptom nodes contain states: 'find' and 'not find' [14] [15].

The implementation of Bayesian network is done by calculating the probability of each injury and disease based on the symptoms that the user entered in Identification page. Based on these symptoms, the application will calculate the joint probability between symptoms and the injury or disease.

The Identification page contains 36 questions of symptom, 2 radio buttons for each questions (radio button Yes and radio button No), and 2 buttons at the bottom of the page (Check button and See Solution button). This interface design in this page allows the user to see all of the questions. Furthermore, the default answer for each question is No. Therefore, the user only needs to answer the question that matches with the condition of the casualty.

In order to calculate the probability of each injuries, this application uses some formulas. These formulas can be seen in Chapter 3 Method, especially in 3.2 Calculate Probability formula 4 and formula 6.

The first formula used by this application is formula 4. This formula is used to calculate the probability of every injury and disease given several symptoms from user's answer. The next formula used by this application is formula 6. It is used mainly to calculate  $P(S1 | D)$  in formula 4.

The S1 in formula 6 can be replaced with other symptom because it is only an example. Formula 6 is used because the data in database is in form of number of cases, not probability. Therefore, formula 6 is chosen to calculate the probability. After all of probability has been calculated, the application then will find the maximum probability which indicates the most possible injury or disease.

From several test scenarios conducted previously in Chapter 3 Experimental Result, this application able to identify the 22 (twenty two) injuries quite accurate. This can be seen in the experimental results. Another thing is, this application able to tell the user if the input is incorrect by showing a message "cannot find result" in a text view. The process of calculating the probability is quite fast, especially in real android device (not emulator). The time consumed between when the Check button is clicked until the application shows the result is less than 1 second (it happens almost simultaneously). This proves that the Bayesian network able to handle the medical diagnostic problem quite well and fast.

## V. CONCLUSIONS

ES First Aid is an android application developed to help the user when facing a critical or life threatening situation. ES First Aid provides an expert system feature to help the user identify the casualty's injury or disease, and informations about first aid. In the expert system feature, this application is able to identify twenty two injuries and diseases. In order to identify these twenty two injuries and diseases, ES First Aid implements a knowledge-based expert system, especially using Bayesian Network.

From several tests conducted, the application able to run well and give result as expected. For example, when the user enter the correct symptoms, this application able to identify it and show the result. However, if the symptoms are incorrect, the system will not be able to identify it and show the message. Another example is the See Solution button will work based on the result of the identification process. If the

system able to identify it, See Solution button will display a new page containing the related information. Otherwise, See Solution button will do nothing.

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