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Expert System For Diagnosis of Hypertension Disease Using Naive Bayes Method

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Abstract. *Hypertension is a disease that occurs to arteries that causes the supply of oxygen and nutrition that the body needs to be blocked. Hypertension is often called a silent killer, because it is a kind of disease that is very harmful but comes without awareness to its victim. People with hypertension in average are up to 40 years old and it happened all of his after life . In common hypertension caused by heredity, unhealthy lifestyle, and triggered by the more salty consumption, alcohol and stress. An expert system could be the solution to solve the problem because this system works just like an expert and was created by the naïve Bayes method with the rules and basic system that are the same just like the hyperantion desease. Through this application, users can consult with this system just like usually people consult with the expert to diagnose the sign that happened to the user and find the solution of what happened to themselves.*

Keywords : *Expert Systems, Hypertention, Naive Bayes*

1. INTRODUCTION

High blood pressure, also called hypertension, is a medical condition in which the pressure of the blood against the walls of the arteries is high enough that it can eventually cause health problems, such as heart disease. This is because the heart has to work harder than usual to circulate blood through the blood vessels throughout the body. Blood pressure is usually measured with a tool called a sphygmomanometer which consists of a pump, a pressure gauge, and a rubber cuff. This tool measures blood pressure in units called millimeters of mercury (mm Hg). Diagnosing high blood pressure is not easy because of the limited equipment and only a few experts can treat this disease. Hypertension is a disorder of the blood vessels that causes the supply of oxygen and nutrients carried by the blood to be blocked to the body's tissues that need it. A history of hypertension that coincides with an unhealthy lifestyle such as consuming tobacco, high fat consumption, lack of fiber, excessive salt consumption, lack of exercise, alcoholism, obesity, high blood fat and stress, will increase the risk of complications such as myocardial infarction, stroke, and kidney failure [1].

In Indonesia, hypertension is the third leading cause of death after stroke and tuberculosis, which is 6.7% of the population of deaths at all ages. In Indonesia, the problem of hypertension tends to increase. The prevalence in urban areas is 39.9% (37.0% - 45.8%) and in rural areas 44.1 (36.2% - 51.7%) [2]. According to the Joint National Committee on Prevention Detection, Evaluation, and Treatment of *High Blood Pressure VII/ JNC 2003* hypertension is a condition

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where systolic blood pressure ≥140 mmHg and diastolic pressure ≥90 mmHg [3].

In diagnosing a disease in the medical field, tools such as artificial intelligence applications are needed, therefore an expert system was created to diagnose hypertension. With this expert system, it can make it easier for people to diagnose hypertension because hypertension is a deadly disease without being accompanied by symptoms first as a warning to its victims. This study aims to obtain a model of an expert system application that uses naive bayes in diagnosing symptoms of hypertension that can be done by the public. In general, this study is intended to obtain solutions from the results in the form of consultations, diagnoses, and predictions. As in the medical world, consultations, diagnoses and predictions are very reliable because the results can anticipate and determine the type of disease suffered precisely, quickly and accurately.

*Naive Bayes*is a simple probability classifier based on Bayes' theorem. This method is used so that users can communicate with the expert system that will be designed so that it can make it easier for users to use the expert system that is created. Expert systems are generally systems that try to adopt human knowledge to computers, so that computers can solve problems as experts usually do or in other words, expert systems are systems that are designed and implemented with the help of certain programming languages to be able to solve as experts do. Expert systems can be a solution to solving problems because this system works like an expert and is designed using the naive Bayes method by looking at the rules and rule bases that exist in hypertension [4].

Through this application, users can consult with the system as if consulting an expert to diagnose the symptoms that occur in users and find solutions to the problems faced. This expert system is created by providing questions that require a 'yes' or 'no' answer, according to or not or with several answer choices that are recommendations from the symptoms that occur. For this reason, in this study a system will be designed with the title "Expert System for Diagnosing Hypertension Disease Using the Naive Bayes Method at Aloe Saboe Hospital, Gorontalo City".

2. METHOD

System Expert

Expert systems are computer-based applications that are used to solve problems as thought by experts. The expert referred to here is a person who has special skills who can solve problems that cannot be solved by lay people. For example, a doctor is an expert who is able to diagnose the disease suffered by a patient and can provide treatment for the disease. This program acts as an intelligent consultant or advisor in a particular area of expertise, as a result

of the collection of knowledge that has been collected from several experts [5].

Expert systems consist of user interface components, expert system database components, knowledge acquisition facility components, and inference mechanism components. The advantages of expert systems include (1) with expert systems lay people can work like experts; (2) can carry out processes repeatedly automatically; (3) store the knowledge and expertise of experts; (4) can take and preserve the expertise of experts; (5) can operate in dangerous environments; (6) has reliability; (7) is able to work with incomplete information and contains uncertainty; (8) saves time in decision making.

Naive Bayes

*Naive Bayes*is a simple probability classifier based on Bayes' theorem. The advantage of the classifier is that it requires only a small amount of training data to estimate the parameters (means and variances of the variables) needed for classification. Since independent variables are assumed, only the variances of the variables for each class need to be determined, not the entire covariance matrix. In the process,*Naive Bayes*assume that there is or is not a*feature*in a class is not related to the presence or absence of*feature*others in the same class [4].

Bayes' Theorem States:

$$P(B|A) = \frac{P(A|B)\,P(B)}{P(A)}$$

Where :

P(B|A) = Probability of B if the type of disease is known AP(B|A) = Probability of evidence A if hypothesis B is known

P(B) = Probability of hypothesis B regardless of any evidence P(A) = Probability of evidence of disease A

Using Bayes' theorem, equation (1) can be written as follows:

(1) $$V_{MAP} = argmax_{vjeV} \frac{P(a_1 a_2 \ldots a_n|V_j)P(v_j)}{P(a_1 a_2 \ldots a_n)}$$

(2) Where :

VFOLDER =Highest probability.

P(vj) = Chance of getting this type of disease

P(a1 a2... an|vj) = Probability of attributes (input) if the condition vj is known. P(a1 a2... an) = Probability of attributes (input)

Because the value of P(a1 a2... an) is constant for all vj so this equation can be written:

VMAP = argmax vjeV P (vj | a1, a2, a3, ... an|vj)P(vj)

Where :

VFOLDER = Highest probability.

P(vj) = Probability of type j of disease

P(a1 a2... an|vj) = Probability of attributes (input) if the state vj is known

(3)

To calculate P(a1 a2... an|vj)P(vj) is increasingly difficult because the number of symptoms P(a1 a2... an|vj)P(vj) can be very large. This is because the number of symptoms is equal to the sum of all combinations of symptoms multiplied by the number of categories.

The calculation of the Naïve Bayes classifier is to calculate P(ai|vj) using the formula:

$$P(a_i|v_j = \frac{n_c+mp}{n+m} \quad (4)$$

Where :

nc= number of records in the learning data where v = vj and a = aip = 1/ number of types of class / disease

m = number of parameters / symptoms

n = number of records in the learning data, v = vj / each class

Hypertension

Hypertension is a disorder of the blood vessels that causes the supply of oxygen and nutrients carried by the blood to be blocked to the body tissues that need it. This disease seems to be a threat because suddenly someone can be diagnosed with high blood pressure [3].

Table 1 Classification of blood pressure measurements

Pressure Classification	c Blood Pressure (mmHg)	c Blood Pressure (mmHg)
Normal	< 120	< 80
Prehypertension	120-139	80-89
Hypertension	≥ 140	90
Hypertension Stage 1	140-159	90-99
Hypertension Stage 2	≥ 160	≥ 100

Classification of blood pressure measurements for adults (aged ≥18 years) is based on the average of blood pressure measurements or more at two or more clinical visits (Table 1). The blood pressure classification includes 4 categories, with normal values at systolic blood pressure (SBP) <120 mmHg and diastolic blood pressure (DBP) <80 mmHg. Pre-hypertension is not considered a disease category but identifies patients whose blood pressure is likely to increase to the classification of hypertension in the future. There are two levels (stages) of hypertension, and all patients in this category should be treated with medication. Hypertensive

crisis is a clinical condition characterized by very high blood pressure that is likely to cause causing or has caused target organ abnormalities. Usually characterized by high blood pressure >180/120 mmHg, categorized as emergency hypertension or urgent hypertension. In emergency hypertension, blood pressure increases extremely accompanied by acute target organ damage that is progressive, so blood pressure must be lowered immediately (in minutes - hours) to prevent further target organ damage [6].

Hypertension that is not treated properly is divided into two groups, namely risk factors that cannot be changed and risk factors that can be changed.

1. Unmodifiable risk factors
    a. Age
    b. Gender
    c. Heredity (Genetics)
2. Modifiable risk factors
    a. Overweight (obesity)
    b. Smoke
    c. Lack of physical activity
    d. Excessive salt consumption
    e. Dyslipidemia
    f. Excessive Alcohol Consumption
    g. Psychosocial and Stress

3. RESULTS AND DISCUSSION

Type Disease And Symptom

The types of diseases and symptoms of hypertension can be seen in table 2.

Table 2 Types Disease

Code	Name Disease
P01	Chronic Hypertension
P02	Superimposed Pre-Eclampsia
P03	Gestational Hypertension
P04	Mild Pre-Eclampsia
P05	Severe Pre-Eclampsia
P06	Eclampsia
P07	Hypotension

Table 3 Symptom Disease Hypertension

Code	Symptom
G01	Blood pressure > 120/80 mmHg
G02	Blood pressure < 120/80 mmHg
G03	Normal blood pressure or equal to 120/80 mmHg
G04	Gestational age < 20 weeks
G05	Gestational age > 20 weeks
G06	Proteinuria/urine dipstick test
G07	Platelets < 100,000 mm3
G08	Trismus/Mouth opening disorder
G09	Fatigue
G10	Faint
G11	Depression
G12	Stres
G13	Seizures
G14	Proteinuria Result 2.0 g/day or > 2+ dispstick
G15	Proteinuria results > 300 mg/day or > 1+ dyspstick
G16	Oliguria/urinary disorders
G17	Urine volume/day < 400 ml/hour
G18	Muscle spasm/Muscle tension
G19	Headache
G20	Blood pressure increases > 160/110 mmHg
G21	Fetal growth retardation
G22	Elevated levels of ALT or AST enzymes
G23	LDH/Lactate Dehydrogenase increased
G24	Fever
G25	Stiff neck
G26	Disorientation
G27	Visual impairment
G28	Vomit
G29	Difficulty concentrating
G30	The seizures that occur are generalized
G31	Severe headache
G32	History of hypertension before pregnancy
G33	Multipara
G34	History of hypertension runs in the family
G35	Proteinuria is persistent
G36	Heartburn
G37	Thrombocytopenia
G38	History of epilepsy
G39	Loss of consciousness
G40	Stiff face
G41	Stiff neck
G42	Stiff neck
G43	Stiff abdominal wall

Manual Calculation Using Naive Bayes

An example of a calculation using the Naïve Bayes classification can be applied to patient number 1 who experiences symptoms number 1, 9, 31, 40.

Description of symptoms:

1. Blood pressure > 120/80 mmHg
9. Fatigue
31. Severe headache
40. Stiff face

Calculation steps

Hypertensive disease 5: Severe Pre-Eclampsia n = 1

p = 1/7 = 0.14285714 m = 43

1.nc= 1

9. nc= 0

31. nc = 1

40. nc = 0

Calculating the value of P(ai|vj) and calculating the value of P(vj)

P (1|PB) = $\frac{1 + 43 \, x \, 0.14285714}{1+43}$ = 0.14285714

$\frac{0 + 43 \, x \, 0.14285714}{1+43} = 0.13961039$

P (9|PB) =

P(31|PB)=$\frac{1 + 43 \, x \, 0.14285714}{1+43}$ =0.14285714 P(40|PB)=$\frac{0 + 43 \, x \, 0.14285714}{1+43} = 0.13961039$ P(PB) = 1/7 = 0.14285714

Calculate P(ai|vj) x P(vj) for each v

P(PB) = 1/7 = 0.14285714

= P(PB) x [P (1|PB) x P (9|PB) x P(31|PB) x P(40|PB)]

= 0.14285714 x [0.14285714 x0.13961039 x 0.14285714 x0.13961039]= 5.68252473e-5

In the case study taken in this study is Severe Pre-Eclampsia disease. Initially looking at the symptoms experienced by patients with Severe Pre-Eclampsia disease. After that the next step is to determine the nc value (number of records in the data) for the Pre-Eclampsia disease class. After we know the value, the next step is to calculate the P (ai | vj) value and the P (vj) value for each symptom of Severe Pre-Eclampsia disease. After the results are obtained, then calculate the P (ai | vj) x P (vj) value for each v according to equation 3 above. The results obtained for severe Pre-Eclampsia disease with its symptoms get a result of 5.68252473e-5. This should be compared with other symptoms to find out other types of diseases suffered by the patient.

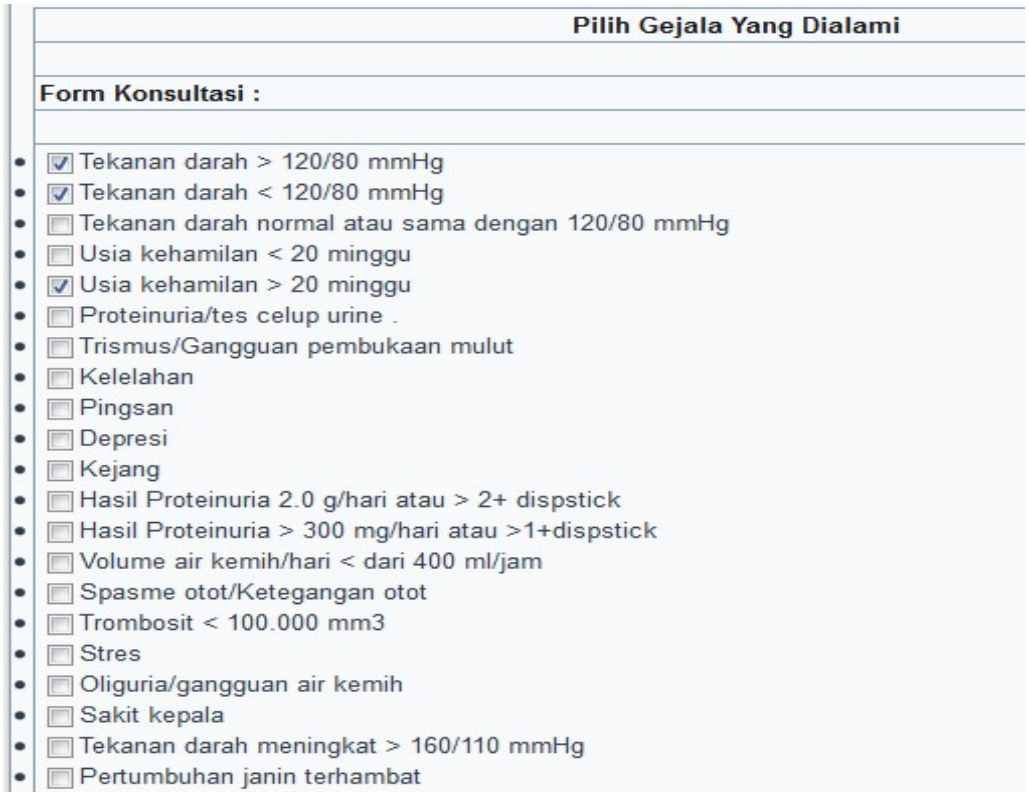
Steps to Run the System

The following is a display of the initial menu which is the main display:

Picture 1 Main menu view

This form is the main menu form where patients can start to diagnose the hypertension they are suffering from.

Symptoms Menu Page



Picture 2 Symptom Menu View

This form is used by patients to select the appropriate symptoms experienced by the patient to determine the hypertension disease suffered by the patient.

Diagnostic Results Page

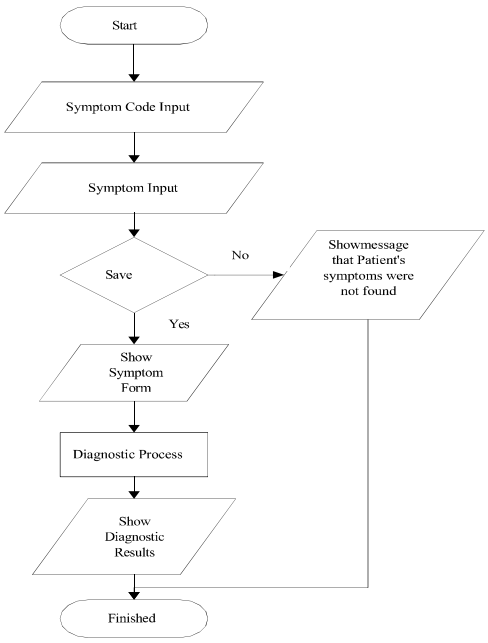
Picture 3 Diagnostic Result Display

This form is used to view the diagnostic results after the patient enters the symptoms experienced and suffered by the patient.

System Testing

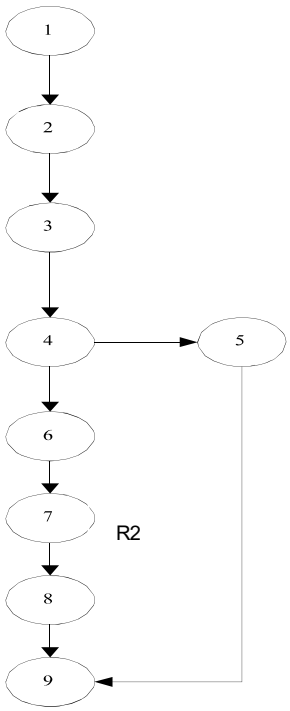
White Box Testing

1. Diagnosis Form



R1

2. Flowgraph



Picture 7. Flow chart

3. *Cyclomatic Complexity*

Picture 8.Flowgraph

Cyclomatic complexity V(G) for flow graphs is calculated using the formula:

V(G)=E-N+2

From the flowgraph above we get:

- Region (R) = 2
- Node (N) = 9
- Edge (E) = 9
- Predicate Node (p) = P + 1

1. V(G) = E – N + 2

= 9 – 9 + 2

= 2

2. V(G) = P + 1

= 1 + 1

= 2

3. *Cyclometic Complexity (CC)* =R1,R2=2

Based on the flow sequence, a flow graph basis group is obtained as follows: R1 = 1-2-3-4-6-7-8-9

R2 = 1-2-3-4-5-9

Black Box Testing

In system testing, it will be ensured that an event or input will run the right process and produce output that matches the design. For black box testing, the diagnostic data form is taken as a measurement:

Table 4. Black box testing table

Input /Event	Results Which expected	Results Testing
Select Login Menu	Display the login menu by entering your username and password then click login.	Success
Select the patient data menu	Displays a form to be filled in by the patient in the form of Name, Gender, Date of Birth, Address and Telephone Number then	Success

	click register	
Select Symptom List	Displays a list of symptoms suffered by the patient	Success
Select disease data and solutions	Displays disease data and solutions suffered by patients by filling in disease codes, types of examinations, definitions and so on. the solution is then saved	Success
Select Diagnosis	Displays diagnostic results that match the symptoms selected by the patient as well as solutions to the disease experienced.	Success
Select exit	Closing the application	Success

4. CONCLUSION AND SUGGESTIONS

From the results of the study above, several things were found that can be concluded that the expert system for hypertension using the naive bayes method can help the public in diagnosing hypertension. The calculation of this expert system is calculated based on the rule-based process. After testing several main processes using naive bayes, the system has generally worked well. Based on the tests that have been carried out, the author provides suggestions that in making the next system, it can be added with more interesting program features, in addition it is hoped that the next system can be developed with other calculation models, such as: Fuzzy, GAP, or others and of course develop into an android-based application so that the public will find it easier to access it.

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