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Expert System for Diagnosing Cancer Using Bayes Theorem Method

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Abstract: Cancer is a dangerous disease that is not contagious and is caused by abnormal cells or tissues that can grow rapidly. The rapid development of this network will cause several complications of this disease which develop rapidly as well. Adam Malik General Hospital is one of the government hospitals that has complete facilities to treat cancer patients. Because it is a regionally centralized general hospital, each patient has quite a long queue when conducting consultations and treatment, this can result in physical fatigue in patients because it takes too long in the queue. To overcome these problems, we need a system that can provide information and detect early cancer diagnoses. So that the doctor can use the results of the diagnosis issued by the system so that it can be analyzed further. This of course can speed up the time the patient is in the examination, so that the treatment process can run effectively and efficiently. An expert system is a system that can store information from an expert, such as a doctor, for example. One of the methods that can be used is the Bayes Theorem method, which is a theory of probable conditions that calculates the probability of an event that depends on evidence. From the results of the trials that have been carried out, the results show that the patient suffers from cancer, namely breast cancer with a value of 81.60%.

Keywords : Certainty Factor , Cancer, Expert System.

1. Introduction

Cancer is a non-communicable disease caused by abnormal cells or tissues that can develop so that it interferes with metabolism and grows and develops rapidly. If the network has grown rapidly then some of the complications of this disease can also spread quickly as well. The spread of this cancer through the blood vessels or lymph vessels. All the elements that make up an organ have the potential to spread cancer. Starting from a tumor mass, cancer cells can develop very malignantly (p2ptm.kemkes.go.id, 2023).

Adam Malik Medan Hajj Center General Hospital is a government hospital managed by the central government with the Regional Government of North Sumatra Province, which is located

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in the city of Medan. Haji Adam Malik Hospital has adequate health equipment, services and facilities, so that people who are sick who cannot be treated by district/city regional hospitals will be referred to this hospital. One of the services that has complete facilities is in handling cancer such as radiology, nuclear medicine and chemotherapy. Because it is a regional centralized hospital, every patient who will do consultation and treatment must queue with a long queue. This will certainly make the patient feel bored to the point of experiencing fatigue in the queue.

To reduce these problems, it is necessary to build a system that can provide information and detect early diagnoses of cancer. So that the results of the diagnosis issued by the system can be used by doctors in analyzing further examinations of patients. With this system, it is hoped that it will be able to cut the time for examinations carried out by doctors on patients, so that the process of treating patients can run effectively and efficiently.

Bayes' theorem is a theory of probability conditions that takes into account the probability of an event (hypothesis) depending on other events (proof). Future events can be predicted if previous events have occurred (Batarius & Tedy, 2017). This method has been widely used by researchers, one of the researchers with the title Expert System in the Diagnosis of Pulmonary Embolism Using the Bayes Theorem Method. The conclusion from this study is that the role of the Bayes Theorem concept is to produce a system for diagnosing Pulmonary Embolism, where the system is able to make decisions as well as those of experts (Saripurna, 2018).

In the journal (Khairani & Sulindawaty, 2020) with the title Expert System Diagnosing Worms in Etawa Using the Bayes Theorem Method. In his research, the resulting system can be used to diagnose intestinal worms in etawa goats and provide solutions from an expert. The resulting information can be used as an alternative first course of action regarding intestinal worms in etawa goats, including the types of diseases, symptoms, and solutions.

2. Literature

This previous research is one of the references in conducting research so that it can enrich the theory used in reviewing the research conducted. Some of these previous studies were used as references in enriching the study material in this study. Among the researchers is the title Expert System in Diagnosing Pulmonary Embolism Using the Bayes Theorem Method. The conclusion from this study is that the role of the Bayes Theorem concept is to produce a system for diagnosing Pulmonary Embolism, where the system is able to make decisions as well as those of experts (Saripurna, 2018).

In the journal (Khairani & Sulindawaty, 2020) with his research that the resulting system can be used to diagnose intestinal worms in Etawa goats and provide solutions from an expert. The resulting information can be used as an alternative first action regarding intestinal worms in etawa goats, including the types of diseases, symptoms, and solutions. Meanwhile (Tarigan et al., 2020) in his research entitled Application of the Bayes Theorem Method in Expert Systems to Diagnose Cardiovescular System Disorders at Adam Malik Haji Center General Hospital. The conclusion in this study is based on the research results, the design of an expert system can be used in the process of diagnosing Cardiovescular Disease. Based on the results of the research, the design of an expert system can be used in the process of diagnosing Cardiovescular Disease.

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The next researcher (Ramadhan et al., 2021) with the title Expert System for Diagnosing Diseases in Coffee Plants Using the Bayes Theorem Method. The conclusion from the research is that the results of data analysis in an expert system program for detecting coffee plant diseases use the Bayes theorem method by looking at the symptoms of the coffee plant physically. With the design of the system can make it easier to diagnose coffee disease. By searching for data obtained from an experienced expert. Assisting the Plantation Service in providing solutions to farmers' complaints about coffee plant diseases experienced by these farmers.

3. Methods

3.1. Types of Research

The research method is carried out to look for something systematically by using the scientific method and applicable sources. In the process of this research aimed at the Central General Hospital (RSUP) H. Adam Malik Medan, especially in diagnosing cancer by providing results and obtaining the desired information. The results of the conceptualization will be poured into a complete research method with a literature study pattern, collecting the data needed to analyze cancer diagnoses using the Bayes Theorem method.

3.2. Research Supporting Data

In a study needed a data that can support the success of a study. Research data is used as an analysis process to get results or a conclusion. In this study, the data used for men were using the Bayes Theorem method, namely symptom data, disease data obtained from Adam Malik General Hospital in Medan which handles cancer. This data was obtained based on observation and direct interviews with experts. These data will later be used to test the extent of the accuracy of cancer diagnosis using the Bayes Theorem method.

3.3. Application of the Method

The application of the method is needed in solving a problem that is difficult to determine in the assessment process. In diagnosing a disease, accurate data analysis must be carried out to obtain a conclusion. Many methods used in diagnosing a disease have been carried out by many researchers. In expert system research diagnosing cancer using the Bayes Theorem method as an analysis in diagnosing cancer.

Table 1. Symptom Probability Value Based on Disease

Code	Symptom Name	Disease Type Code			
		P01	**P02**	**P03**	**P04**
G01	Weight loss	0.2	0.16	0.31	0.33
G02	Nausea and vomiting.		1		
G03	Yellow skin and eyes *(icteric*).	1			
G04	The upper right abdomen hurts.		1		
G05	Gastrointestinal bleeding in the form of vomiting black blood.		1		
G06	Lost appetite	0.17	0.18	0.29	0.35

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G07	Black defecation.		1		
G08	Weight loss drastically	0.52	0.48		
G09	Skin tight and sore.		1		
G10	Shortness of breath accompanied by wheezing	0.37			0.63
G11	The voice becomes hoarse	1			
G12	Persistent cough, sometimes with phlegm and blood	0.35			0.65
G13	Pain in the chest	1			
G14	Easily tired	0.40		0.60	
G15	Headache	1			
G16	Breathing problems	1			
G17	Memory decline	1			
G18	Disturbed body balance	1			
G19	Pain in joints and bones	1			
G20	Difficulty in swallowing	1			
G21	Phlegm with blood	1			
G22	Abnormal vaginal bleeding			1	
G23	Pelvic pain			1	
G24	Problems urinating			1	
G25	Swollen foot			1	
G26	Unusual vaginal discharge			1	
G27	Pain during intercourse			1	
G28	Constipation		0.38	0.63	
G29	Spots of blood in the urine			1	
G30	Texture changed				1
G31	There is a lump in the breast				1
G32	Yellow discharge from the breast				1
G33	Lumps in the armpits				1
G34	Nipple shape changes				1
G35	Bleeding on the nipples				1

A patient has the following symptoms of cancer:

1. Weight loss (G01)
2. Loss of appetite (G06)
3. Shortness of breath accompanied by wheezing (G10)
4. Cough constantly, sometimes accompanied by phlegm and blood (G12)
5. Texture change (G30)
6. There is a lump in the breast (G31)
7. Yellow discharge from the breast (G32)

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8. Lump in armpit (G33)
9. Bleeding on the nipple (G34)

From the symptoms that have been described, the system will process according to the application of the Bayes method. After the calculation process is complete, it will conclude the diagnosis of the disease experienced by the patient.

1. Look for the probability value of the disease Symptom

a. Lung Cancer (P01)
P(G01|P01)*(P(P01) = 0.19 * 0.2 = 0.038
P(G06|P01)*(P(P01) = 0.19 * 0.17 = 0.0332
P(G10|P01)*(P(P01) = 0.19 * 0.37 = 0.0705
P(G12|P01)*(P(P01) = 0.19 * 0.35 = 0.0665

b. Liver Cancer (P02)
P(G01|P02)*(P(P02) = 0.18 * 0.16 = 0.0288
P(G06|P02)*(P(P02) = 0.18 * 0.18 = 0.0332

c. Cervical Cancer (P03)
P(G01|P03)*(P(P03) = 0.30 * 0.31 = 0.093
P(G06|P03)*(P(P03) = 0.30 * 0.29 = 0.0874

d. Breast Cancer (P04)
P(G01|P04)*(P(P04) = 0.33 * 0.33 = 0.1089
P(G06|P04)*(P(P04) = 0.33 * 0.35 = 0.1153
P(G10|P04)*(P(P04) = 0.33 * 0.63 = 0.2076
P(G12|P04)*(P(P04) = 0.33 * 0.65 = 0.2145
P(G30|P04)*(P(P04) = 0.33 1 = 0.33
P(G31|P04)*(P(P04) = 0.33 1 = 0.33
P(G32|P04)*(P(P04) = 0.33 1 = 0.33
P(G33|P04)*(P(P04) = 0.33 1 = 0.33
P(G35|P04)*(P(P04) = 0.33 1 = 0.33

2. Add up the probability value of each symptom.

PG01 = P(G01|P01) * P(P01) + P(G01|P02) * P(P02) + P(G01|P03) * P(P03) + P(G01|P04) * P(P04)
PG01 = 0.038 + 0.0288 + 0.093 + 0.1089

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PG01 = 0.2687

PG06 = P(G06|P01) * P(P01) + P(G06|P02) * P(P02) + P(G06|P03) * P(P023) + P(G06|P04) * P(P04)
PG06 = 0.0332 + 0.0332 + 0.0874 + 0.1153
PG06 = 0.2691

PG10 = P(G10|P01) * P(P01) + P(G10|P04) * P(P04)
PG10 = 0.0705 + 0.2076
PG10 = 0.2781

PG12 = P(G12|P01) * P(P01) + P(G12|P04) * P(P04)
PG12 = 0.0665 + 0.2145
PG12 = 0.281

PG30 = P(G30|P04) * P(P04)
PG30 = 0.33

PG31 = P(G31|P04) * P(P04)
PG31 = 0.33

PG32 = P(G32|P04) * P(P04)
PG32 = 0.33

PG33 = P(G33|P04) * P(P04)
PG33 = 0.33

PG35 = P(G35|P04) * P(P04)
PG35 = 0.33

3. Calculate the value of the probability of disease.

a. Lung Cancer (P01)

P01 = P(G01|P01) / P(P01) + P(G06|P01) / P(P01) + P(G10|P01) / P(P01) + P(G12|P01) / P(P01)
P01 = (0.038/ 0.2687) + (0.0332/ 0.2691) + (0.0705/ 0.2781) + (0.0665/ 0.281)
P01 = 0.1414 + 0.1234 + 0.2535 + 0.2367

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P01 = 0.7549

b. Liver Cancer (P02)
P02 = P(G01|P02) / P(P02) + P(G06|P02) / P(P02)
P02 = (0.093/ 0.2687) + (0.0874/ 0.2691)
P02 = 0.1072 + 0.1234
P02 = 0.2306

c. Cervical cancer (P03)
P03 = P(G01|P03) / P(P03) + P(G06|P03) / P(P03)
P03 = (0.0930/ 0.2687) + (0.0874/ 0.2691)
P03 = 0.3461 + 0.3247
P03 = 0.6708

d. Breast cancer (P04)
P04 = P(G01|P04) / P(P04) + P(G06|P04) / P(P04) + P(G10|P04) / P(P04) + P(G12|P04) / P(P04) + P(G30|P04) / P(P04) + P(G31|P04) / P(P04) + P(G32|P04) / P(P04) + P(33|P04) / P(P04) + P(G34|P04) / P(P04)
P04 = (0.1089/ 0.2687) + (0.1153/ 0.2691) + (0.2076/ 0.2781) + (0.2145/ 0.281) + (0.33/0.33) + (0.33/0.33) + (0.33/0.33) + (0.33/0.33) + (0.33/0.33)
P04 = 0.4053 + 0.4286 + 0.7465 + 0.7633 + 1 + 1 + 1 + 1 + 1
P04 = 7.3437

4. Find the Bayes value by adding up the probability value of the disease.

$$\sum_{Gn}^{n} = P01 + P02 + P03 + P04$$

= 0.7549 + 0.2306 + 0.6708 + 7.3437
= 9

4. Results And Discussion

The step that needs to be taken is to calculate the percentage of disease, so that the results of the percentage of each disease will be known.

a. Lung Cancer(P01)
P01 = 0.7549 / 9
P01 = 0.0839
P01 = 0.0839 * 100 %
P01 = 8.39 %

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b. Liver Cancer (P02)
P02 = 0.2306 / 9
P02 = 0.0256
P02 = 0.0256 * 100 %
P02 = 2.56%

c. Cervical Cancer (P03)
P03 = 0.6708 / 9
P03 = 0.0745
P03 = 0.0745 * 100 %
P03 = 7.45%

d. Breast Cancer (P04)
P04 = 7.3437/9
P04 = 0.8160
P04 = 0.8160 * 100 %
P04 = 81.60%

From the calculation process using the Bayes Theorem method above, it can be seen that the patient has cancer, namely breast cancer (P04) with a value of 0.8160 or 81.60%.

5. Conclusion

In this research, with an expert system for diagnosing cancer using the Bayes theorem method, it can help Adam Malik General Hospital in diagnosing cancer in patients and overcoming queues of patients who will conduct consultations more effectively and efficiently. Helping patients get service or treatment faster so as to minimize patient queuing time and reduce physical fatigue experienced by patients due to waiting in line too long. Based on the results of trials that have been carried out on this system, the results show that the patient suffers from cancer, namely breast cancer with a value of 81.60%. So that after that the doctor can immediately analyze further about the cancer in the patient.

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