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IMPLEMENTATION OF FORWARD INFERENCE REASONING IMPLEMENTING THE DEMPSTER-SHAFER METHOD FOR DIAGNOSIS OF LUNG DISEASE SYMPTOMS Tonni Limbong 1, Alex Rikki 2 1Universitas Katolik Santo Thomas Medan, 2Universitas Imelda Medan Tonni.budidarma@gmail.com, alexrikisinaga@gmail.com Abstract Article Info Artificial intelligence is an effort to transfer intelligence that is added to a system that can be regulated in a scientific context or can be called artificial intelligence so that machines (computers) can do work as humans can do. Lung disease is a condition in which the lungs cannot function normally.

Some of the most common include asthma, chronic obstructive pulmonary disease (COPD), pneumonia, tuberculosis, and lung cancer. The Dempster-Shafer method was first introduced by Dempster, who experimented with uncertainty models with a range of probabilities rather than a single probability. Application of the Dempster-Shafer method to diagnose lung disease, it can be concluded that inference techniques are easy to use in designing expert systems to get a conclusion but, it has weaknesses in finding these conclusions if the system has a large enough knowledge base and this will be very much use time and hinder the consultation process. Received 02 March 2021 Revised 15 April 2021 Accepted 01 June 2021 Keywords: Dempster-Shafer, Lung Disease, Expert System 1.

Introduction Artificial intelligence is intelligence that is added to a system that can be regulated in a scientific context or it can be called artificial intelligence (English: Artificial Intelligence) or simply AI, defined as the ability of a system to correctly interpret external

data, to learn from it, and use that learning to achieve Intelligence is created and incorporated into a machine (computer) in order to do work as humans can.

Several kinds of fields that use artificial intelligence include expert systems, computer games, fuzzy logic, artificial neural networks and robotics [1] AI automates repeated learning and discovery through data. But AI is different from hardware-driven robotic automation. Instead of automating manual tasks, AI performs frequent, high-volume, computerized tasks reliably and without fatigue.

For this type of automation, human investigation is still important to organize the system and ask the right questions [2]. AI adds intelligence to existing products. In most cases, AI is not sold as an individual application. However, the products you are already using will be enhanced with AI capabilities, much like Siri was added as a feature on a new generation of Apple products.

Automation, chat platforms, bots and smart machines can be combined with large amounts of data to enhance many technologies at home and in the workplace, from security intelligence to investment analysis. Lung disease is a condition in which the lungs cannot function normally. Some of the most common include asthma, chronic obstructive pulmonary disease (COPD), pneumonia, tuberculosis, and lung cancer. http://infor.seaninstitute.org/index.php/infokum/index JURNAL INFOKUM, Volume 9, No. 2,Juni 2021 ISSN : 2302-9706 INFOKUM is licensed under a Creative Commons Attribution-Non Commercial 4.0

International License (CC BY-NC 4.0) 107 The disease can be of genetic origin, smoking habits, air pollution, and exposure to chemicals in the workplace. These diseases generally show symptoms, namely difficulty breathing, chronic coughing, wheezing, and chest pain. Severe conditions can cause the patient to cough up blood, chronic infections that do not resolve with treatment, and respiratory failure [3], [4].

Lung disease is the most common health disorder in the world, affecting patients of all ages - men, women, children, the elderly, smokers and nonsmokers. According to the World Health Organization (WHO), sufferers of ASA worldwide reach 235 million people and about three million people die of COPD. In addition, lung cancer is the leading cause of cancer death, both in men and women. This means that one in four cancer deaths is lung cancer.

Lung disease is also the leading cause of death in infants under one year of age [5] The Dempster-Shafer method was first introduced by Dempster, who experimented with uncertainty models with a range of probabilities rather than a single probability. Then in

1976 Shafer published Dempster's theory in a book entitled Mathematical Theory Of Evident.

Dempster-Shafer Theory Of Evidence, shows a way to give weight to belief according to the facts gathered. In this theory can distinguish uncertainty and ignorance. Dempster-Shafer theory is a representation, combination and propogation of uncertainty, where this theory has several characteristics that are instutitively in accordance with the way of thinking of an expert, but a strong mathematical basis [6]. In general, the Dempster-Shafer theory is written in an interval: [Belief, Plausibility].

Believe is a measure of confidence in evidence / symptoms. If it is 0, it indicates that there is no certainty, and if it is 1 it indicates certainty. The believe data is obtained from expert input. Plausibility is a measure of distrust of evidence / symptoms. If it is 1, it indicates that there is no certainty, and if it is 0, it indicates certainty. Palusability data is obtained from 1 - believe [7]. 2. METHOD 2.1.

Research Method In writing this study, the authors did several things to obtain the necessary data, including [8]: 1. Data collection methods Some of the methods used by the author are: a. Literature search To get a valid theoretical result to be used as a basis, the author searches for several reference books from libraries and electronic media (internet) about expert systems and the Dempster-Shafer method and computer books. b.

Interview Conducting direct consultations or questions and answers with people who know more about the expert system and the Dempster-Shafer method 2. Needs Analysis a. The needs analysis used is the Dempster-Shafer method, which is carried out to determine the desired input and output. b. System analysis and design System design is a step taken to create a program design based on the desired input and output. c.

System testing After making the system design, the next step is to implement the design results into the program d. Writing research reports The author of this research report is the final result of the research that has been done. 2.2. Expert System Expert systems are computer-based systems that use knowledge, facts and reasoning techniques to solve problems that usually only an expert in the field can solve [9], [10]. Basically an expert system is applied http://infor.seaninstitute.org/index.php/infokum/index JURNAL INFOKUM, Volume 9, No.

2,Juni 2021 ISSN : 2302-9706 INFOKUM is licensed under a Creative Commons Attribution-Non Commercial 4.0 International License (CC BY-NC 4.0) 108 to support problem solving activities. Some of the solving activities referred to include: decision

making, knowledge fusing, designing, planning, forecasting, regulating, controlling, diagnosis (diagnosing), formulation (prescribing), explanation (explaining), giving advice (advising) and training (tutoring).

In addition, an expert system can also function as a clever assistant to an expert [2]. In its preparation, an expert system combines inference rules with a specific knowledge base provided by one or more experts in a particular field. The combination of these two things is stored in the computer, which is then used in decision making for solving certain problems [2], [11]. 2.3.

Knowledge Base The knowledge base contains knowledge for understanding, formulation and problem solving. This expert system component is composed of two basic elements, namely facts and rules. Facts are information about objects in a certain problem area, while rules are information about how to get new facts from known facts [2].

In case studies of knowledge-based systems there are several characteristics that are built to assist us in shaping a series of architectural principles. These principles include: a. Knowledge is the key to the strength of an expert system. b. Knowledge is often uncertain and incomplete. c. Often poor knowledge of specifications. d. Amateurs become masters gradually. e. Expert systems must be flexible. f. Expert systems must be transparent.

The history of research in the field of artificial intelligence has shown over and over again that knowledge is the key to any intelligent system. 2.4. Knowledge Representation Knowledge representation is a technique to represent the knowledge base obtained in a certain schema / diagram so that it can be seen the relationship / relationship between one data and another.

This technique helps the knowledge engineer in understanding the structure of knowledge that will be made by the expert system [11]. The representation language must be able to make a programmer able to express the knowledge needed to get a problem solution, can be translated into a programming language and can be stored. It must be designed so that the facts and other knowledge contained in it can be used for reasoning.

Knowledge can be represented in simple or complex forms, depending on the problem. 2.5. The Dempster-Shafer theory There are various kinds of reasoning with a complete and very consistent model, but in fact there are many problems that cannot be resolved completely and consistently. This inconsistency is the result of the addition of new facts.

Such reasoning is called non-monotonic reasoning.

To overcome this inconsistency, reasoning can be used with the Dempster-Shafer theory. [6], [7] In general, the Dempster-Shafer theory is written in an interval: [Belief,Plausibility] 1. Belief (Bel) is a measure of the strength of evidence in support of a set of propositions.

If it is 0, it indicates that there is no evidence, and if it is 1 it indicates certainty. 2. Plausibility (Pl) is denoted as: Pl(s) = 1 − Bel (- s).. [Plausibility is also 0 to 1. If you are sure of -s, then you can say that Bel (-s) = 1, and Pl (-s) = 0. In the Dempster- Shaf ty, te is a fre ofscrent denotrame iver ofussi from a set of hypotheses. Itpose io ratdence meaes tent al evie directly supports every element.

For that we need a probability density function (m). The value m defines notonlhe ems but so a s sSo ain ems, tsubse of? i2n.

109 sumofallmin subset? s Ifte s infaton abl to select a hypothesis, then the val m Ifts known t X iubset ?, wher1 is auncti densy, and Y isso a subs ? th asa on y, hen comnatfon and 2 3 n formed, namely: ....[3] Misalkan : With: G = Nutrition; L = Environment; I = Infection; K = Poisoning; Its purpose is to relate the confidence measure to 0 elements.

Not all evidence directly supports every element. For example, infection may only be supportive (G, L, K). For that we need a probability density function (m). The value m defines not only the elements of 0, but also all its subsets. So if 0 contains n elements, then the subsets of 0 all add up to 2. We must show that the sum of all m in subset 0 equals 1.

Supposing there is no information to select the four hypotheses, then the value M (0) = 1,0 If then it is known that Trauma is a symptom of poisoning, infection, and the environment with m = 0.8, then: M (G,L,K) = 0,8 3. RESULTS AND DISCUSSION 3.1. Rule Basis Design In data design, it will be explained how the data contained in the system is in accordance with its function as input data or system output data.

Table 1. Bronchitis, clinical symptoms Symptoms Weight Value a. Dry cough b. Cough up with phlegm after 2-3 days c. The sound is there lenders d. Thick, yellow phlegm e. Shortness of breath complaining of retrostenal pain f. Wheezing 0.2 0.3 0.2 0.1 0.1 0.1 Table 2. Rare Episodic Asthma, Clinical symptoms Symptoms Weight Value a. Hard to

breathe b. Wheezing for 3-4 days c. Cough for 10-14 days d. Excessive mucus production e.

There are at the age of 3-6 years f. Attacks 3-4x a year g. Symptoms appear at night 0.2 0.3 0.2 0.1 0.1 0.05 0.05 Table 3. Frequent Episodic Asthma, Clinical symptoms Symptoms Weight Value a. Hard to breathe b. Cough c. Excessive mucus production d. Symptoms appear at night 0.1 0.3 0.1 0.1

2,Juni 110 e. Occurs at age <3 years, and 8-13 years f. Attacks 3-4x a year 0.2 0.2 Table 4. Chronic / Persistent Asthma Clinical symptoms: Symptoms Weight Value a. Occurs at the age of 6 months or <3 years b. Symptoms appear at night c. Growth disorders d. Hard to breathe e. Wheezing every day f. Cough g.

Excessive mucus production 0.2 0.3 0.2 0.1 0.1 0.05 0.05 Table 5. Severe and Recurrent Episodic Asthma Clinical symptoms Symptoms Weight Value a. Hard to breathe b. Wheezing c. Cough d. Excessive mucus production e. ARI (upper respiratory tract infection) f. In young children and before school 0.3 0.1 0.1 0.2 0.2 0.1 Table 6. Persistent Asthma in Infants Clinical symptoms Symptoms Weight Value a. Hard to breathe b.

Wheezing with takhipnu for a few days or a few weeks c. Cough d. Excessive mucus production e. 3-12 months old 0.3 0.3 0.2 0.1 0.1 Table 7. Hypersecretory Asthma Clinical symptoms Symptoms Weight Value a. Hard to breathe b. Cough c. Excessive mucus production d. The sound of crackling breath e. There are small children and at the age of starting school 0.1 0.3 0.2 0.3 0.1 Table 8. Asthma due to physical load Clinical symptoms Symptoms Weight Value a.

Hard to breathe b. Wheezing c. Cough d. Excessive mucus production e. After doing physical activity 0.1 0.3 0.2 0.3 0.1 Table 9. Asthma with allergens Clinical symptoms Symptoms Weight Value a. Hard to breathe b. Delirious 0.1 0.2

International 111 c. A hard, dry night cough d. Cough occurs at 1-4 in the morning e. At the age of 2-6 years 0.2 0.3 0.3 Table 10. Night Cough Clinical symptoms Symptoms Weight Value a. Hard to breathe b. Delirious c. Cough d. Excessive

mucus production e. Asthma at 1-4 in the morning 0.1 0.3 0.2 0.3 0.1 Table 11. Bad Asthma in the Morning. Clinical symptoms Symptoms Weight Value a. Occurs in young children and babies b.

The temperature suddenly rises to 39-40 C c. Accompanied by high febrile seizures d. Restless child e. Breathing fast and shallow f. Nasal lobe breathing g. Cyanosis around the nose and mouth h. Accompanied by vomiting and diarrhea 0.05 0.2 0.2 0.2 0.05 0.1 1 1 Table 12. Bronchopneumonia Clinical symptoms Symptoms Weight Value a. Body shivering b. The baby has seizures c. The temperature rises to 39-400 C d. Hard to breathe e.

Nasal lobe breathing f. Cyanosis around the nose and mouth g. Chest pain h. Cough at first dry and with phlegm i. The child prefers to lie on the affected chest 0.05 0.1 0.2 0.2 0.2 0.05 0.1 0.05 0.05 Table 13. Lobar Pneumonia Clinical symptoms Symptoms Weight Value a. ARI b. Cough and cold c. Hard to breathe d. Shallow and rapid breathing e. Restless child f. Cyanotic g. Nasal lobe breathing h. Delirious 0.05 0.2 0.2 0.2 0.05 0.1

1 1 Table 14. Acute Bronchiolitis Clinical symptoms Symptoms Weight Value a. Asthma, b. Bronchitis, 0.3 0.3 112 c. Bronchopneumonia 0.4 Table 15. Atelectasis Clinical symptoms Symptoms Weight Value a. Occurs 24 hours after surgery b.

Dyspnu (shortness of breath) c. Cyanosis (bluish) d. Tachycardia (rapid pulse) e. Chest pain f. Restless g. Increase in body temperature 0.05 0.3 0.2 0.1 0.1 0.05 0.2 Table 16 Massive atelectasis Clinical symptoms Symptoms Weight Value a. Dispnu expirator b. Crackles are wet and crisp 0,5 0,5 Table 17. Obstructive emphysema Clinical symptoms Symptoms Weight Value a. Crepitation (air in the skin) is emphysematic 1 Table 18.

Emphysema Bulosa Clinical symptoms: Symptoms Weight Value a. Pain in the affected side of the thorax b. Dispnu c. Cough d. Sneezing e. Due to strenuous physical training 0.1 0.2 0.1 0.3 0.3 Table 19. Pneumothorax Clinical symptoms Symptoms Weight Value a. Hard to breathe b. Delirious c. Cough d. The sound of a lender e. After doing excessive physical activity 0.3 0.2 0.1 0.3 0.1 Table 20. Empyema Torasis Clinical symptoms Symptoms Weight Value a.

The temperature was suddenly high b. Tachycardia c. Dyspnea d. Cyanosis e. Coughs f. Looks very sick g. Remittance fever 0.1 0.3 0.2 0.05 0.1 0.05 0.2 From the disease and symptom data above, it can be represented as the rule below. This knowledge

representation is used to determine the search process or determine the conclusions of the diagnosis. The following is the discussion 1 .

Rule 1 Bronchitis If the cough is dry And cough with phlegm after 2-3 days 114 And the voice is lenders And thick, yellow phlegm And shortness of breath And retrostenal pain And wheezing Then Bronchitis 2.

Rule 2: Asthma Episodic Disease Rare If coughing up thick and yellow sputum And shortness of breath And wheezing And attacks 3-4 times a year And symptoms at night And ages 3-6 years Then Asma Episodik Jaran 3. Rule 3 Frequent Episodic Asthma If coughing up thick and yellow sputum And shortness of breath And wheezing And attacks 3-4 times a year And symptoms at night And hay fever And <3 years old And ages 8-13 years Then Asma Episodik Often 4.

Rule 4 Chronic / Persistent Asthma If coughing up thick and yellow sputum And shortness of breath And wheezing And symptoms at night And growth disorders Then Chronic / Persistent Asthma 5. Rule 5, Severe & Recurring Episodic Asthma If coughing up thick and yellow sputum And shortness of breath And wheezing And ages 3-6 years And ISPA (Upper Respiratory Tract Infection) Then Episodic Asthma Severe & Recurring 6.

Rule 6 Persistent Asthma in Infants If coughing up thick and yellow sputum And shortness of breath And wheezing And <3 years old Then Persistent Asthma in Babies 7. Rule 7 Hypersecretory asthma If coughing up thick and yellow sputum And shortness of breath And wheezing And the sound of crackling breath And ages 3-6 years Then Asthma Hypersecretion 8.

Rule 8 Asthma due to Physical Burden If coughing up thick and yellow sputum And shortness of breath And wheezing And it hurts when doing physical activity Then Asma due to Physical Load 9. Rule 9 Asthma with Allergens If the cough is dry And thick, yellow phlegm And shortness of breath And wheezing And ages 3-6 years And after being exposed to allergens And cough at night at 1- 4 am Then Asthma with Allergens 10.

Rule 10 for Night Cough If coughing up thick and yellow sputum And shortness of breath And wheezing And asthma at 1-4 am Then Cough tonight 11. Rule 11 for Bad Asthma in the Morning

115 If age <3 years And breathing shallow and fast And the child becomes restless And cyanotic (bluish) And the body temperature rises And seizures with fever And vomiting accompanied by diarrhea Then Bad Asthma in the Morning 12.

Rule 12 Bronchopneumonia disease If cough with phlegm after 2-3 days And shortness of breath And cyanotic And breathe out the nostrils And pain in the chest And body temperature rises And seizures with fever And the body is shivering Then Bronchopneumonia 13. Rule 13, Lobaris pneumonia If cough with phlegm after 2-3 days And shortness of breath And wheezing And ISPA (Upper Respiratory Infection) And shallow and fast breathing And the child becomes restless And cyanotic And breathe out the nostrils Then Pneumonia Lobaris 14.

Rule 14 Acute Bronchiolitis If accompanied by other diseases, asthma, bronchitis Then Acute Bronchiolitis 15. Rule 15: Atelectasis If shortness of breath And tachycardia (rapid pulse) And the child becomes restless And cyanotic (bluish) And pain in the chest And occurs 24 hours after surgery And body temperature rises Then Atelectasis 16.

Rule 16: Massive Atelectasis If shortness of breath And the crackle is wet & crispy Then Massive Atelectasis 17. Rule 17 Obstructive Emphysema disease If crepitus is in the skin area (as if there is air under the skin) Then Obstructive Emphysema 18. Rule 18 for Emphysema Bulosa If the cough is dry And shortness of breath And it hurts when doing physical activity And pain in the chest Then Emphysema Bulosa 19.

Rule 19 Pneomothorax disease If coughing up thick and yellow sputum And shortness of breath And wheezing And it hurts when doing physical activity Then Emphysema Bulosa 20. Rule 20 for Emphysema Torasis If the cough is dry And shortness of breath And tachycardia (rapid pulse) And looks very sick And cyanotic And body temperature rises And the body is shivering Then Emphysema Turosis 3.2. Application of Dempster-Shafer in the Diagnosis of Lung Disease

117 In the example below, we will look for certainty of lung disease using the rules in table 21. Below: Table 21. Example of Rule for Lung Disorders with Certainty Factors NO. Sympoms Weight 1 Hard to breathe 0,1 2 Body shivering 0,1 3 Body temperature rises 0,05 4 Cyanotic 0,1 5 tachycardia (rapid pulse) And looks very sick 0,05 Then: To calculate the WEIGHT value of selected lung diseases

using Symptom-1 and Symptom-2 WEIGHT (SYMPTOM-1, SYMPTOM-2) = WEIGHT (SYMPTOM-1) + WEIGHT (SYMPTOM-2) - [(WEIGHT (SYMPTOM-1) x WEIGHT (SYMPTOM-2)] = 0.1 + 0.1 - (0.1) (0.1) = 0.19 Then combine it with R? next, which in this example is SYMPTOM-3 WEIGHT (SYMPTOM-1, SYMPTOM-2, SYMPTOM-3) = WEIGHT (SYMPTOM-1, SYMPTOM-2) + WEIGHT (SYMPTOM-3) - ((WEIGHT (SYMPTOM-1, SYMPTOM-2) x WEIGHT (SYMPTOM- 3)] = 0.19 + 0.05 - (0.19) (0.05) = 0.24 - 0.0095 = 0.2305 (23%) That is, the combination of SYMPTOM-1, SYMPTOM-2, and SYMPTOM-3 will produce 23% chance that the conclusion of Emphysema Turosis lung disease will occur.

The page below is used to start a disease consultation, while the pictures from this page can be seen in figures 1 and 2 below: Figure 1. Consultation Form Step-1 Figure 2. Step-2 Consultation Form After successfully logging in, it will immediately go to the main system administrator page, which can be seen as shown in Figure 3 below: Figure 3. System Administrator Main Page The Disease page is used to enter Disease data and Symptom, while the image looks like in Figures 5 and 6 below:

International License (CC BY-NC 4.0) 118 Figure 5. Disease List page Figure 6. Symptom List page 4. CONCLUSIONS After designing and applying the software, it can be concluded that the inference technique is easy to use in designing expert systems to get a conclusion but, it has weaknesses in finding these conclusions, namely it is very slow in its search, especially if the system has a large enough knowledge base and this.

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