

Implementation Of Fuzzy Multi-Criteria Decision Making To Design An Expert System For Prediction Of Digestive Diseases At Dogs

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Abstract

A dog is a kind of animal that is often looked after at home. Except for being known as a human's friend, a dog is also able to be trained to do many things. The age of the dog depends on the type of race. If it's fed well, exercises, and visits the doctor regularly, a dog can live longer. Dogs are very sensitive to certain diseases; one of them is intestinal disease. An expert system of a dog's digestion is built for the dog's lover so that they know exactly what's disease, which relies on the appearance of the symptoms. The symptoms of the different intestinal diseases look almost similar. For this reason, we need an appropriate method to get a precise result. Fuzzy multiple-criteria decision-making can help make the right decision that has some consideration points. This method is also equipped with optimal ultimate selections, which leads to a very precise result. The goal of this application is to know the right kind of disease and its therapy. This study has been validated by matching the results of the application with the doctor's diagnosis. The compatibility level is 80%.

Keywords: Dog (Canis Lupus Familiaris); Digestion; Optimal Ultimate; FMCDM

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Introduction

Dogs (Canis Lupus Familiaris) are one of the domestic animals that are popular with humans as pets because they are relatively easy to care for (Kurniyawan et al., n.d.), (Justa & Lyngdoh, 2023). The existence of dogs is very popular among certain communities because, apart from being known as human friends, dogs are also kept as guards, hunters, scouts, and trackers, and can be trained for various things, from helping the blind to walk (guide dogs) to being a guard at home to help maintain airport security (military dogs).

Based on pet statistics in Indonesia, dogs are the most popular pets (Anugrah et al., 2023; Brumm, 2022). The types of dogs consist of local dogs and purebred dogs kept in different rearing conditions (B. V. Sinaga & Hariani, 2019). This is thought to affect the dog's health. Dogs are susceptible to various diseases, ranging from mild to dangerous. Like mammals, dogs are also susceptible to fatigue due to hot weather, air with high humidity, or drastic changes in temperature. Some dog diseases have various symptoms that, if not treated as soon as possible, can lead to death. With so many symptoms, it is difficult for people to determine the type of disease their pet dog is experiencing (Nusa et al., 2022). Seeing the phenomena that often occur, accurate and easy information is needed and helps the public in the process of diagnosing diseases in dogs by developing technology, namely an expert system (Ramadhan et al., 2023).

Expert systems are a branch of artificial intelligence (AI) (Sudrajat et al., 2018). The implementation of expert systems is widely used for commercial purposes because expert systems are seen as a way of storing expert knowledge in certain fields into programs so that computers can make intelligent decisions and carry out reasoning (M. D. Sinaga & Sembiring, 2016), (Iskandar, Kartowagiran, Haryanto, Amiruddin, et al., 2023). This system tries to adapt human knowledge to computers so that they can solve problems as experts usually do. The expert system will provide a list of symptoms until it can identify an object based on the answers received (Sihotang et al., 2018), (Zalisky et al., 2022). The application of an expert system for diagnosing disease in dogs requires a method. The method used in this research is the Fuzzy Multi-Criteria Decision Making (FMCDM) method.

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Digestive disease is the disease that most often attacks, disrupting the dog's metabolic process. The following describes 10 types of digestive diseases in dogs along with the recovery therapy recommended by doctors (Fathimah et al., 2023):

1. Dysphagia: Difficulty swallowing due to inability to chew.
2. Acute Gastritis: Infection of the stomach caused by viruses, bacteria, or irregular eating patterns.
3. Chronic Gastritis: Stomach infections at a more severe level are characterized by more frequent duration of vomiting accompanied by blood and mucus.
4. Diarrhea: Infection of the digestive tract caused by bacteria, parasites or fungi which causes the feces to become liquid.
5. Acute Enteritis: Enteritis, also called inflammation of the small intestine, is caused by consuming food and drinks contaminated with bacteria or viruses.
6. Chronic Enteritis: Infections in the small intestine or large intestine due to rotten food, foreign objects, excessive food, or more serious food additives.
7. Melena: The most obvious symptom is a mixture of feces with blood. Caused by bleeding in the front digestive system.
8. Dyschezia: This is difficulty defecating (defecating).
9. Hematochezia: This is bleeding during defecation (stools) due to bacterial infections in the lower digestive tract such as the large intestine.
10. Constipation: Difficulty defecating accompanied by pain for a long period of time.

There are several previous studies that are similar to this research, such as research entitled "Expert System Diagnoses Eye Diseases in Dogs Using Bayes' Theorem Method" by (Ramadhan et al., 2023), "Expert System for Detecting Computer Damage Using the Forward Chaining Method" by (Kusnadi et al., 2019), "Expert System Diagnoses Diseases in Humans Caused by Viruses Using the Web-Based Dempster Shafer Method" by (Agustian et al., 2023), "Expert System for Diagnosing Diseases in White Sea Bass Fish Based on Web" by (Laba, 2020), "Expert system application for diagnosing eye diseases using an Android-based fuzzy multi-criteria decision making method" by (Irawan & Ma'mur, 2023), "Designing an expert system application to diagnose human disease" by (Kusnadi, 2013), "Expert System to Determine Types of Diseases in Children Caused by Gadgets" by (Wilson, 2020), "Employee Recruitment Decision Support System Using Ahp-Topsis Method" by (Agusli et al., 2020), "A comprehensive review of fuzzy multi criteria decision making methodologies for energy policy making" by (Kaya et al., 2019), "Expert system application for diagnosing psychological disorders using the case based reasoning method using web-based CodeIgniter" by (Arifa & Yuswardi, 2022), "Design a learning stress prediction expert system using a backpropagation neural network algorithm" by (Kusnadi & Putra, 2015), "Application of a Web-Based Expert System for Disease Diagnosis in Baby Kailan Hydroponic Plants" by (Manik, 2022), and "Web-based expert system for diagnosing malaria, dengue fever and measles using a fuzzy multiple criteria decision making method" by (Hendrawaty et al., 2020), (Sahibu et al., 2022). However, in this research, there has been no research on the design of an expert system for predicting digestive diseases in dogs using fuzzy multi-criteria decision-making.

Therefore, this research aims to analyze and design an expert system for diagnosing diseases in dogs that includes disease information, both symptoms and solutions, and plays a role in replacing and imitating the reasoning process of an expert in solving specification problems. The result of the research is a computerized expert system for diagnosing diseases in dogs that can be used to provide useful information for diagnosing diseases in dogs.

Method

This method involves a thorough search and understanding of existing scholarly materials to gather comprehensive insights into the subject matter. By focusing on expert systems and digestive diseases in dogs, the study aims to establish a solid theoretical foundation, integrating knowledge gleaned from a variety of authoritative sources (Paul & Barari, 2022). The methods used in this research are as follows:

- a. Literature studies are carried out by searching for and understanding library materials such as journals, books, and other articles related to expert systems and digestive diseases in dogs.

- b. Data collection is carried out by collecting the type of disease, disease symptoms, and digestive therapy that is suitable for dogs.
- c. Interviews were conducted with the veterinarian at the Vet D'Villa clinic, namely Dr. Dhany Rosnaedy, to prove the accuracy of the data that had been collected through a literature study and observation and whether it was in accordance with medical science.
- d. Data analysis is carried out by processing data according to the relationship between attributes and disease symptoms and rating ratings as a comparison for each relationship.
- e. Design includes user interface and program flow.
- f. Application implementation is built based on the design using the PHP programming language.
- g. Testing aims to determine application performance and investigate errors.8. Documentation of the research process from start to finish

Planning begins by compiling an admin and user flowchart. The admin flowchart explains the flow that the admin must go through when adding, deleting, or changing data(Iskandar & others, 2023). Meanwhile, the user flowchart explains the flow that the user goes through when using the diagnosis process, figure 1, 2 & 3.

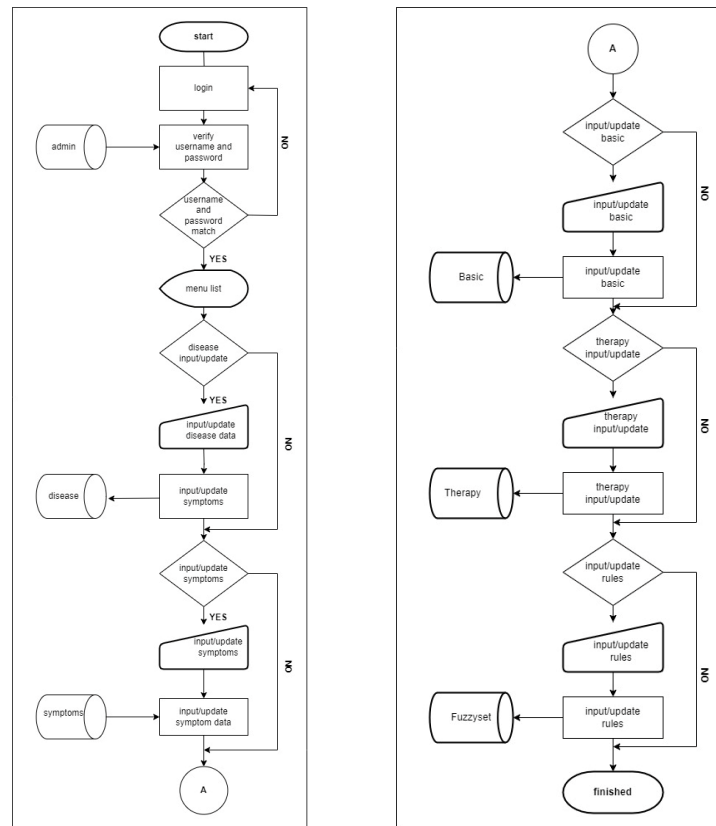


Figure 1. Admin Flowchart

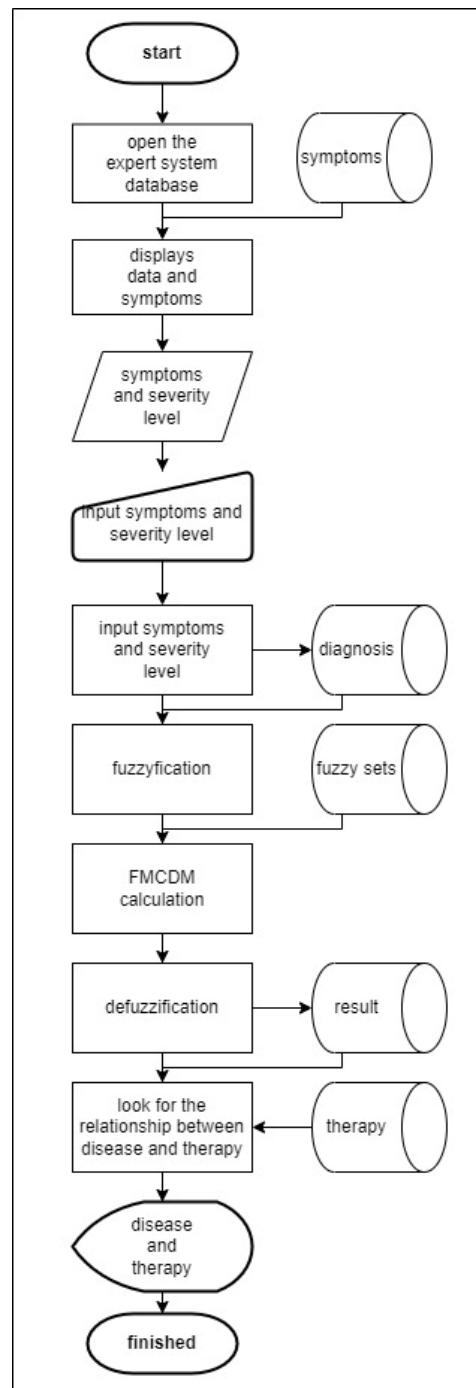


Figure 2. User Flowchart

After the flowchart, the next stage is the dependency diagram. Once this flowchart has been developed or analyzed, the attention then shifts to the dependency diagram (Abdullah et al., 2019; Iskandar, Kartowagiran, Haryanto, Suyanto, et al., 2023). A dependency diagram illustrates the relationships and interdependencies among various components, tasks, or elements within a system or project. It visually represents how changes, developments, or dependencies in one aspect can affect or influence others.

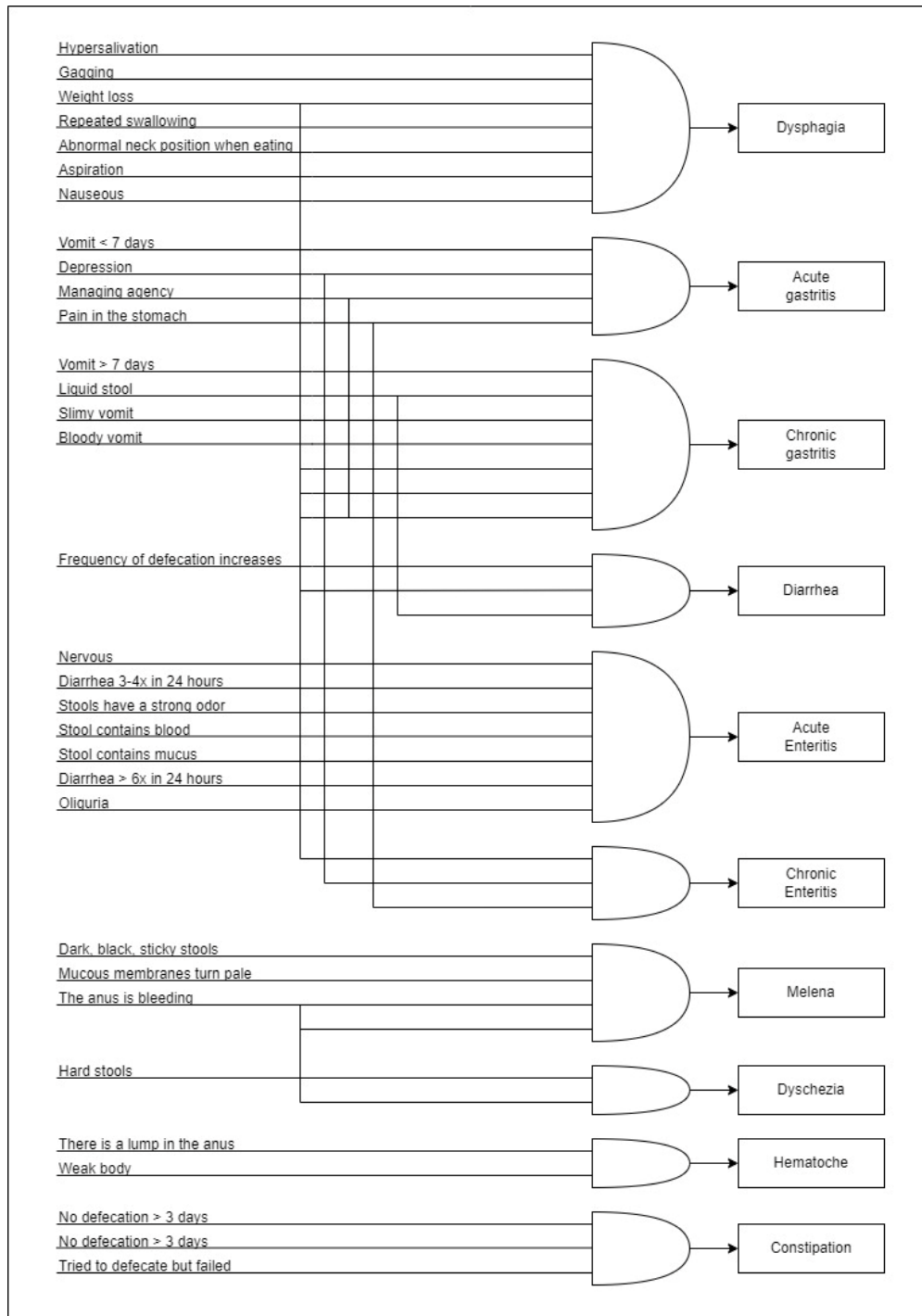


Figure 3. Dependency Diagram

This diagram illustrates the relationship between symptoms and disease and communicates that a visual representation is provided to elucidate the connection between symptoms and diseases. The term "diagram" refers to a visual aid, such as a chart or graph, which is employed to depict information. In this context, the diagram aims to elucidate how symptoms are interrelated with specific diseases.

Results and Discussion

Result

A. Development Tool Specifications

The specifications used in the design of this application are :

1. Toshiba Satellite P745 laptop with Windows 7 OS
2. Intel Core i3 with a 2.30-GHz 64-bit processor
3. 6GB RAM
4. DirectX11 supports graphics devices
5. XAMPP v3.2.1

After analysis and design, the following is the appearance of the application's home page, as seen in Figure 4.



Figure 4. Login Page

The admin needs to fill in the username and password first, then press the login button. After the application carries out the process of matching the username and password and they match those in the database, the administrator can carry out the data management process. If the login process is successful, the next menus will appear, namely database settings. The following is an administrator-only page, as seen in Figure 5.



Figure 5. Administrator Home Page

On this page there is a brief explanation of what administrators can do, such as changing disease data, symptoms, therapy, and basic data settings (relationship between disease, symptoms and therapy). If the Next button is pressed, it will direct the admin to the disease data settings. Or administrators can also make other data settings, namely by making choices on the tab, as seen in Figure 6.

Figure 6. Diagnostics page

The diagnosis page will display five answer choices, as previously explained. Users are required to answer around 30 questions in the form of symptoms. The results of user input will be stored in the database and then calculated using the fuzzy multicriteria decision-making method. Furthermore, on the final page of this expert system, the calculation results will be displayed in the form of the type of disease the dog is suffering from along with the type of therapy recommended. The types of disease displayed have previously gone through the fuzzy multicriteria decision-making calculation process. If it is still unclear about the disease being displayed, the user can see the meaning of the name of the disease on the information page. The therapy shown is also based on advice from medical books and can be done at home as first aid.

B. Trial

After the application is completed, testing can be carried out. Testing is carried out by giving the expert a list of symptoms, then the expert will determine the disease based on these symptoms. The author also carries out the input process in the application according to the same list of symptoms, then the results will be compared. This test was carried out with the aim of finding out how much this application matches the results of the doctor's diagnosis. The following is a Table 1 listing the symptoms submitted to experts.

Table 1. Expert System Trial Table

No	Symptom	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
1	Hypersalivation (Excessive salivation)	S							
2	Gagging (reflex to remove food from the mouth)	S							
3	Trying to swallow repeatedly	S							
4	Abnormal neck position when swallowing	K							
5	Aspiration (cough)	K							
6	Nauseous	K							
7	Weight loss	K	K	S	K				
8	Pain in the abdomen (stomach area)	K	S	S	S				
9	Managing agency	K	S	S	K				
10	Depression	K	K	S					
11	Vomit	K	S						
12	Bloody vomiting								
13	Slimy vomit		J						
14	The frequency of defecation (defecation) increases			S	S				S
15	Liquid stool			S	SS	S	SS		

No	Symptom	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
16	Stools have a strong odor				S	S	SS		S
17	Mucous stools					S	S		
18	Bloody stools					K	S		
19	Dark, black, sticky stools					K			
20	Hard stools								
21	Oliguria (little to no urine)								
22	The skin of the anus turns pale								
23	Anus bleeding								
24	Lumps in the anus								
25	Weak body	K	S	S	S	S	S	S	K
26	No defecation for more than 3 days							SS	
27	Stomach stiff and hard							S	
28	Tries to defecate but fails							S	
29	Nervous						K		K
30	Appetite goes down							S	S

The next table will explain the comparison of diagnosis results by experts and applications.

Table 2. Comparison Results Table

Case to	Expert Results	Validation Results
1	Dysphagia	Dysphagia
2	Gastritis Akut	Gastritis Akut
3	Diare	Diare
4	Diare	Diare
5	Hematochezia	Diare
6	Enteritis Kronis	Enteritis Akut
7	Konstipasi	Konstipasi
8	Diare	Diare
9	Melena	Melena
10	Hematochezia	Dyschezia

Discussion

The design of an expert system for predicting digestive disease in dogs involves a series of steps to identify, collect information, and design appropriate inference logic (Elbasi et al., 2022; Gao et al., 2022). Apart from that, in the context of animal health, it is also necessary to pay attention to applicable ethics and regulations to ensure animal safety and welfare. The Fuzzy Multi-Criteria Decision Making (FMCDM) method is used for decision-making, which combines the concept of fuzzy logic with several criteria to assist decision-making in complex and uncertain situations.

By using the FMCDM method, the expert system can decide which option is appropriate for the disease suffered by the dog because FMCDM has several advantages, one of which is the ability to handle uncertainty and ambiguity in information. By utilizing fuzzy logic, the system can handle variability and uncertainty in criteria values (Rai et al., 2022). It is important to remember that, although FMCDM has these advantages, the choice of this method must be in accordance with the specific characteristics and needs of the decision-making problem at hand because there are still limitations in handling situations where the required data is not available or the uncertainty is very high (Baydas & Pamučar, 2022). The success of FMCDM often depends on the expertise and good understanding of the experts involved in designing the system and determining its rules. So there needs to be consideration when selecting and implementing FMCDM in a particular decision context.

Conclusions and Suggestions

Conclusion

From the research that has been carried out, it can be concluded that an expert system for predicting dog digestive disease using the fuzzy multiple criteria decision-making method has been successfully built. Based on the validation results, the suitability of the system with the expert is 80%. This expert system determines the name of the disease based on symptoms by aggregating the suitability value of each weight inputted by the user with the rating determined by the

expert. After that, it is optimized again by multiplying the results by the degree of optimism. The recommended type of therapy will appear later, after the most appropriate disease results are obtained from previous calculations.

Suggestions

Suggestion Based on the research that has been carried out, there are several suggestions for developing the system that has been designed and built. These suggestions are explained as follows:

1. The diagnosis process needs to be improved so that it is more attractive in appearance and can be operated on more quickly.
2. The application can be equipped with a simple medical dictionary related to dog digestive diseases.

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References

- Abdullah, D., Zarlis, M., Pardede, A. M. H., Anum, A., Suryani, R., Hidayati, P. I., Susilo, E., Sofais, D. A. R., Rosyidah, E., Surya, S., & others. (2019). Expert System Diagnosing Disease of Honey Guava Using Bayes Method. *Journal of Physics: Conference Series*, 1361(1), 12054.
- Agusli, R., Dzulhaq, M. I., & Irawan, F. C. (2020). Sistem Pendukung Keputusan Penerimaan Karyawan Menggunakan Metode Ahp-Topsis. *Academic Journal of Computer Science Research*, 2(2).
- Agustian, T., Fadilah, F. N., Sihombing, J. R. H., & Hidayatullah, T. (2023). Sistem Pakar Mendiagnosis Penyakit Pada Manusia Disebabkan Virus Menggunakan Metode Dempster Shafer Berbasis Web. *Jurnal Inovasi Pengembangan Aplikasi Dan Keamanan Informasi Nusantara*, 1(1), 33–44.
- Anugrah, D., Apada, A. M. S., Rell, F., Suharto, R. H., & Mursalim, M. F. (2023). *Treatment Leptospira Infection In Dog At Pet Vet Clinic, Central Jakarta*.
- Arifa, R., & Yuswardi, Y. (2022). APLIKASI SISTEM PAKAR DIAGNOSIS GANGGUAN PSIKOLOGIS MENGGUNAKAN METODE CASE BASED REASONING MENGGUNAKAN CODEIGNITER BERBASIS WEB. *Jurnal Literasi Informatika*, 1(1).
- Baydas, M., & Pamučar, D. (2022). Determining objective characteristics of MCDM methods under uncertainty: an exploration study with financial data. *Mathematics*, 10(7), 1115.
- Brumm, A. (2022). Pigs as pets: early human relations with the Sulawesi warty pig (*Sus celebensis*). *Animals*, 13(1), 48.
- Elbasi, E., Mostafa, N., AlArnaout, Z., Zreikat, A. I., Cina, E., Varghese, G., Shdefat, A., Topcu, A. E., Abdelbaki, W., Mathew, S., & others. (2022). Artificial intelligence technology in the agricultural sector: a systematic literature review. *IEEE Access*.
- Fathimah, S., Pambudhi, B., & Mulyani, D. (2023). MODEL APLIKASI DIAGNOSIS PENYAKIT ANJING MENGGUNAKAN METODE NAÏVE BAYES. *Prosiding Seminar Nasional Mahasiswa Fakultas Teknologi Informasi (SENAFTI)*, 2(2), 1154–1163.
- Gao, Z., Lou, L., Wang, M., Sun, Z., Chen, X., Zhang, X., Pan, Z., Hao, H., Zhang, Y., Quan, S., & others. (2022). Application of Machine Learning in Intelligent Medical Image Diagnosis and Construction of Intelligent Service Process. *Computational Intelligence and Neuroscience*, 2022.
- Hendrawaty, H., Mina, M., & Azhar, A. (2020). SISTEM PAKAR BERBASIS WEB UNTUK DIAGNOSIS MALARIA, DEMAM BERDARAH, DAN CAMPAK MENGGUNAKAN METODE PENGAMBILAN KEPUTUSAN FUZZY MULTIPLE CRITERIA. *JOURNAL OF INFORMATICS AND COMPUTER SCIENCE*, 6(2), 152–158.
- Irawan, R., & Ma'mur, K. (2023). APLIKASI SISTEM PAKAR UNTUK DIAGNOSA PENYAKIT MATA MENGGUNAKAN METODE FUZZY MULTI CRITERI DECISION MAKING BERBASIS ANDROID. *LOGIC: Jurnal Ilmu Komputer Dan Pendidikan*, 1(4), 907–916.
- Iskandar, A., Kartowagiran, B., Haryanto, H., Amiruddin, E. G., & Said, A. (2023). Implementation of natural language

- processing and machine learning in the chatbot customer service application for new student admission. *AIP Conference Proceedings*, 2704(1).
- Iskandar, A., Kartowagiran, B., Haryanto, H., Suyanto, S., Mustapa, M., & Munawir, M. (2023). Web Based Tolada Village Information System Design. *TEM Journal*, 12(1), 334–340. <https://doi.org/https://doi.org/10.18421/TEM121-42>
- Iskandar, A., & others. (2023). Motorcycle Engine Start System Using Fingerprint and Voice Command. *Inspiration: Jurnal Teknologi Informasi Dan Komunikasi*, 13(1), 69–76.
- Justa, P., & Lyngdoh, S. (2023). Understanding carnivore interactions in a cold arid trans-Himalayan landscape: What drives co-existence patterns within predator guild along varying resource gradients? *Ecology and Evolution*, 13(5), e10040.
- Kaya, I., Colak, M., & Terzi, F. (2019). A comprehensive review of fuzzy multi criteria decision making methodologies for energy policy making. *Energy Strategy Reviews*, 24, 207–228.
- Kurniyawan, A., Ferasyi, T. R., & Hanafiah, M. (n.d.). Survei Prevalensi Ektoparasit pada Populasi Anjing Pemburu (Canis Lupus familiaris) di Kecamatan Jagong Jeget Kabupaten Aceh Tengah. *Jurnal Sain Veteriner*, 39(2), 161–167.
- Kusnadi, A. (2013). Perancangan aplikasi sistem pakar untuk mendiagnosa penyakit pada manusia. *Ultimatics: Jurnal Teknik Informatika*, 5(1), 1–8.
- Kusnadi, A., Antonius, A., Prago, A., Michelle, C., Cahyadi, D. I., & Suhengki, G. C. H. (2019). Sistim Pakar Untuk Medeteksi Kerusakan Komputer Menggunakan Metode Forward Chaining. *TEKINFO*, 1(2 Oktober), 136–143.
- Kusnadi, A., & Putra, I. (2015). Rancang bangun sistem pakar prediksi stres belajar dengan neural network algoritma backpropagation. *Ultimatics: Jurnal Teknik Informatika*, 7(2), 105–112.
- Laba, A. (2020). *Sistem Pakar Mendiagnosa Penyakit pada Ikan Kakap Putih Berbasis Web*. Prodi Teknik Informatika.
- Manik, B. P. (2022). *Penerapan Sistem Pakar Berbasis Web Diagnosa Penyakit pada Tumbuhan Hidroponik Baby Kailan*. Prodi Teknik Infomatika.
- Nusa, F. L., Wibowo, S. A., & Rudhistiar, D. (2022). Sistem Pakar Diagnosis Penyakit Pada Anjing Menggunakan Metode Certainty Factor. *JATI (Jurnal Mahasiswa Teknik Informatika)*, 6(1), 245–252.
- Paul, J., & Barari, M. (2022). Meta-analysis and traditional systematic literature reviews—What, why, when, where, and how? *Psychology & Marketing*, 39(6), 1099–1115.
- Rai, S., Srinivas, R., & Magner, J. (2022). Using fuzzy logic-based hybrid modeling to guide riparian best management practices selection in tributaries of the Minnesota River Basin. *Journal of Hydrology*, 608, 127628.
- Ramadhan, M., Lubis, Z., Pranata, A., Nugroho, N. B., & Erwansyah, K. (2023). Sistem Pakar Mendiagnsoa Penyakit Mata Pada Anjing Dengan Menggunakan Metode Teorema Bayes. *Jurnal Teknologi Sistem Informasi Dan Sistem Komputer TGD*, 6(1), 257–265.
- Sahibu, S., Munsyir, M., Gani, H., Taufik, I., & Iskandar, A. (2022). Analysis Of Themes and Trends in Life Sciences and Biomedical Research Virtual Reality. *Inspiration: Jurnal Teknologi Informasi Dan Komunikasi*, 12(2), 76–88.
- Sihotang, H. T., Panggabean, E., & Zebua, H. (2018). Sistem Pakar Mendiagnosa Penyakit Herpes Zoster Dengan Menggunakan Metode Teorema Bayes. *Journal Of Informatic Pelita Nusantara*, 3(1).
- Sinaga, B. V., & Hariani, N. (2019). Prevalensi dan intensitas ektoparasit pada anjing peliharaan (Canis familiaris) di Kalimantan Timur, Indonesia. *Jurnal Bioterdidik: Wahana Ekspresi Ilmiah*, 7(5), 43–52.
- Sinaga, M. D., & Sembiring, N. S. B. (2016). Penerapan metode Dempster Shafer untuk mendiagnosa penyakit dari akibat bakteri salmonella. *Cogito Smart Journal*, 2(2), 94–107.
- Sudrajat, D., Daengs, G. S. A., Satria, E., Nurmawati, N., Iskandar, A., Khasanah, K., Sururi, A., & Rahim, R. (2018). Expert System Application for Identifying Formalin and Borax in Foods Using the Certainty Factor Method. *Eurasian Journal of Analytical Chemistry*, 13(6), 321–325.
- Wilson, P. (2020). *Sistem Pakar Untuk Menentukan Jenis Penyakit Pada Anak Yang Disebabkan Oleh Gadget*. Prodi Teknik Informatika.
- Zaliskiy, M., Yashanov, I., Okoro, O. C., & Shcherbyna, O. (2022). Analysis of Learning Efficiency of Expert System for Decision-Making Support in Aviation. *2022 12th International Conference on Advanced Computer Information Technologies (ACIT)*, 172–175.