

The Application of the Forward-Backward Chaining Method in Analyzing Oil Palm Plant Diseases at PT. Fajar Agung

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ABSTRACT

Bengabing Plantation is a pure plantation managed by a national private company, PT. Fajar Agung, which operates in the oil palm and rubber plantation sector. A frequent decline in harvest yields has been observed, caused by pests and diseases affecting the oil palm plants. Therefore, a medium is needed to help address this issue—namely, an expert system for diagnosing oil palm diseases. The aim of this research is to develop an expert system that can replicate the knowledge of plantation experts, particularly in the field of oil palm cultivation, into a computerized system by applying the forward-backward chaining method.

Keyword : Data Mining, Student Achievement Prediction, C4.5 Method, Naïve Bayes, Classification



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1. INTRODUCTION

Bengabing Plantation is an oil palm and rubber estate managed by PT. Fajar Agung, a national private company holding a Land Use Right (HGU) over 1,474.36 hectares. One of the main problems faced by the company is a decline in harvest yields caused by pest and disease attacks on oil palm plants. Oil palm (*Elaeis guineensis*) is a strategic commodity with high economic value, contributing significantly to national foreign exchange through its derivative products such as cooking oil, soap, candles, and biodiesel. Improper handling of plant diseases can lead to reduced productivity and even crop failure, resulting in significant financial losses for the company.

However, the limited availability of experts in oil palm cultivation poses a challenge for rapid and accurate disease diagnosis and management. Therefore, a supporting tool in the form of an expert system for diagnosing oil palm diseases is needed. This system is designed to replicate the reasoning process of a human expert in analyzing disease symptoms, by applying the forward-backward chaining method to provide accurate diagnostic results. The implementation of this expert system is expected to enhance the efficiency of disease management in oil palm plantations and maintain sustainable productivity.

2. RESEARCH METHOD

A. Expert System

Expert Systems are a well-established branch of Artificial Intelligence (AI), initially developed in the mid-1960s. The first known Expert System was the General Purpose Problem Solver (GPS), created by Newell and Simon. The term "Expert System" is derived from "Knowledge-Based Expert System," which refers to systems designed specifically to solve complex problems. These systems utilize the knowledge of human experts, encoded into a computer system to simulate expert reasoning (Hastuti et al., 2022).

An Expert System is a computer program that emulates the decision-making ability of a human expert. Experts, in this context, are individuals who possess a deep understanding or specialized skills in a particular domain (Sivaram et al., 2019). According to Arhami, Expert Systems function as a subset of AI aimed at assisting humans in resolving problems that would typically require expert intervention (Pamungkas et al., 2021). They are capable of representing human intelligence through machine-

executable commands, making them a powerful tool for addressing complex issues using expert-level knowledge (Battineni & Amenta, 2020).

One of the significant benefits of Expert Systems is their potential to provide diagnostic support, especially in medical or agricultural contexts. For instance, users can identify diseases by simply selecting and inputting symptoms they experience—without needing to consult an expert directly (Filetus et al., 2021).

B. System Requirements Analysis

The method applied in this research is quantitative research. This research focuses on the collection of numerical and statistical data to measure the variables involved objectively. Data were collected through direct observation at the research location, enabling a process of collecting information in a realistic environment. This quantitative approach was chosen because it was able to provide an accurate and measurable understanding of the phenomenon in the field of research, thus providing a more in-depth and reliable analysis to answer the research question.

C. Research Framework

In conducting research, a systematic procedure is needed so that the research can run smoothly. This research procedure aims to compare the C4.5 and Naïve Bayes algorithms in predicting student academic achievement.

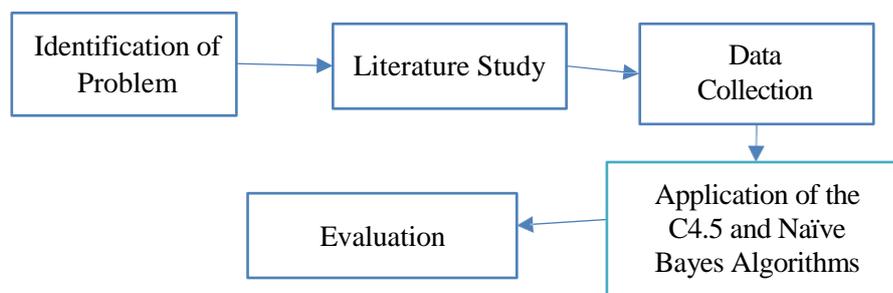


Fig 1. Research Procedure Diagram

The following is an explanation of each stage in the research procedure diagram.

1) Identification of Problem

At this stage, identification of problems relevant to the field of study is carried out. The problem raised in this study is the absence of a system that is able to predict student achievement based on their attendance level.

2) Literature Study

At this stage, a reference search is conducted to support the research topic, either in the form of books or journal articles. This literature search aims to find solutions that can help in solving research problems.

3) Data Collection

a) Observation

This method is used to collect data through direct observation, with the aim of obtaining relevant data. Research data is taken from student achievement records provided by the school.

b) Interview

Interviews are conducted as a systematic way to obtain the necessary information through questions asked to schools that have student achievement data. The goal is to obtain more complete and accurate information for the development of a new system according to research needs.

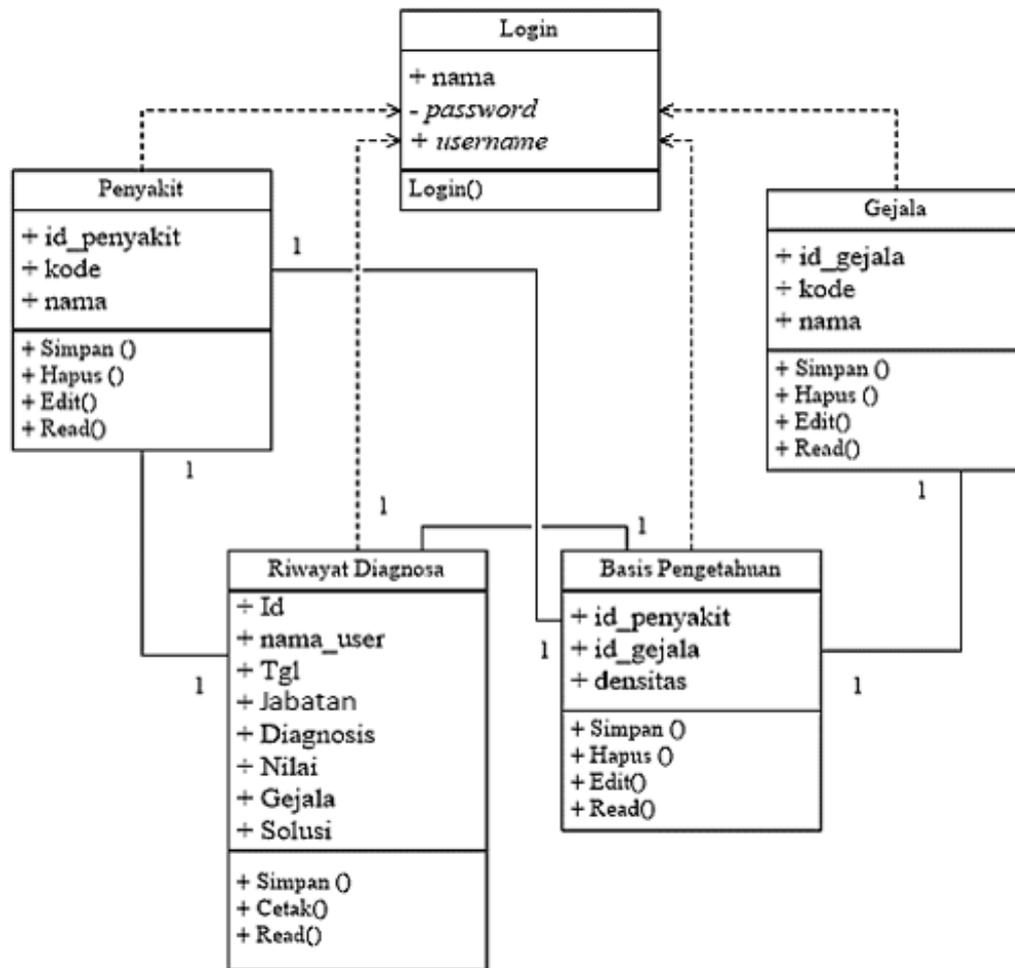
4) Application of the C4.5 and Naive Bayes Algorithms

The C4.5 and Naïve Bayes algorithms are applied to predict student achievement, so that the final results obtained can be used as predictions of student achievement.

5) Evaluation

The evaluation stage is carried out to measure the accuracy of the system developed, to ensure that the predictions produced are in accordance with the research objectives.

D. Flowchart Class Diagram



Gambar 3. 1 Class Diagram

System design is a crucial step in the development of information systems, encompassing the identification of data, workflows, and procedures required to build an efficient and effective system. The objective of system design is not only to meet user needs optimally but also to ensure that the resulting system has clear technical specifications and can be properly implemented. Prior to system construction, a comprehensive and well-structured design is formulated to provide a complete overview of the system's functionality and architecture. At this stage, the design process includes the creation of data storage tables and the development of an intuitive user interface, thereby facilitating seamless interaction between users and the system.

3. RESULTS AND DISCUSSION

A. Data Collection

The following is a case study on disease identification in oil palm plants, used as a test dataset for the implementation of the Forward-Backward Chaining method. A farmer in an oil palm plantation reported that several of his plants were exhibiting alarming symptoms. The observed symptoms include:

1. G01: Abnormal growth
2. G02: Fungal infection
3. G03: Leaf discoloration
4. G09: Middle part of leaflets are small and torn
5. G012: Absence of leaves
6. G014: Leaves appear like small fish bones, short in size, with rotting tips

Based on these symptoms, an initial diagnosis was carried out using the Forward-Backward Chaining method. This approach is expected to assist in analyzing the symptoms and identifying the disease affecting the oil palm plants, thereby enabling the farmer to take appropriate actions to resolve the issue and restore the plant's health. The complete diagnostic steps are outlined below. Based on the decision tree, production rules were derived to represent the disease symptom rules in oil palm plants, as shown below.

B. Expert System Diagnosis Results

The diagnosis process for oil palm disease uses a rule-based method and the K-Means clustering technique.

Rule-Based Diagnosis: Among 7 rules (R1–R7) representing different symptoms and diseases, the matching symptoms detected were G1, G2, G3, G9, G12, and G14. The rule with the highest match was R5, which had a 100% match with the detected symptoms (3 out of 3). Therefore, Rule 5 concludes that the oil palm plant is diagnosed with "Tajuk Disease" (Crown Disease).

K-Means Clustering Analysis: Using a symptom severity scale of 1–10, Euclidean Distance was calculated for each symptom (G1 = 10, G2 = 7, G3 = 8, G9 = 10, G12 = 5, G14 = 2) against three cluster centroids:

- C1 = mild (1),
- C2 = moderate (3),
- C3 = severe (6).

The results showed that 5 out of 6 symptoms fell into Cluster 3 (severe), indicating that the palm tree is experiencing a severe level of Crown Disease.

C. User Interface Display Results

The system's interface includes the following pages:

- Main Page: First page when the system is accessed.
- Diagnosis Page: Used to input symptom data.
- Diagnosis Results Page: Displays the diagnosis outcome.
- Diagnosis Report Page: Provides a printable report.
- Admin Login Form: Authentication for admin users.
- Admin Dashboard: Admin's main interface.
- Visitor Data Page: Admin can view all users who used the system.
- Symptom Data Page: Manage symptoms (add/edit/delete).
- Disease Data Page: Manage diseases (add/edit/delete).
- Knowledge Base Page: Manage rules linking symptoms to diseases.

D. System Testing

System testing was conducted using Black Box Testing to validate all functions. All forms and features — including login, symptom data, disease data, diagnosis result, and report generation — worked as expected and returned valid results.

E. Discussion

The discussion focuses on the specifications and system identification, highlighting the advantages and disadvantages of the expert system built for diagnosing diseases in sweet palm plants using the Forward-Backward Chaining method. Below are the key points.

System Specifications To run the expert system effectively, both hardware and software are needed. The required hardware includes:

1. A laptop or computer with at least a dual-core processor.
2. A minimum of 2GB of RAM.
3. A hard disk with at least 260GB of storage.
4. Monitor, mouse, and keyboard.
5. The necessary software includes:
6. An operating system of at least Windows 7.
7. Browsers like Mozilla Firefox, Chrome, or Microsoft Edge.
8. Local server XAMPP.

System Identification The system has several strengths and weaknesses:

Strengths:

1. The system can diagnose diseases in sweet palm plants using the Forward-Backward Chaining method.
2. It is easy to operate, ensuring that users can understand and use the system with ease.
3. The results from the Forward-Backward Chaining method are sufficiently accurate.

Weaknesses:

The system is limited to diagnosing only sweet palm plant diseases, not other plant diseases.

It only analyzes disease diagnosis for sweet palm plants using the Forward-Backward Chaining method. The system lacks robust data security features, as no data security algorithms have been implemented yet.

This overview shows that while the system is effective for its intended purpose, there are areas that need improvement, particularly in security and expanding the range of plant diseases it can diagnose.

CONCLUSION

In order to diagnose the disease in mustard seedlings using the Forward-Backward Chai method, it is necessary to collect data on symptoms and diseases that are relevant. The application of the Forward-Backward Chaining Method in the expert system to diagnose the disease can be done with satisfactory results. The implementation of this expert system in a Web-based application can be done by using XAMPP as a local server and Sublime Text as a technical editor to code the program. The system can be run through a web browser. The testing of the web-based expert system that has been developed to diagnose diseases in mustard tree plants using the Forward-Backward Chaining method can be done using the Black Box Testing concept. This test aims to ensure that all functions of the system are working properly.

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