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The Use of C4.5 Algorithm for Classification of New Student Admissions in Vocational High Schools (Case Study: Piramida Rancaek Vocation High School)

Dheni Apriansani Budiman¹, Sri Rahayu Indiani²
 STMIK Mardira Indonesia, Bandung ^{1,2}
 dheni@stmik-mi.ac.id¹, srirahayu200207@gmail.com²

Abstract

The New Student Admission is a mandatory process conducted by all educational institutions to maintain the continuity of student cohorts within the educational framework. At Vocational High School Piramida, The New Student Admission process adheres to a traditional methodology, resulting in subjective and protracted selection procedures. Consequently, the author employs the C4.5 algorithm as a classification technique that produces decision trees from potential student data. The created system is intended to manage The New Student Admission process with greater efficiency and objectivity. This study utilizes descriptive analysis, and the system development adheres to Object-Oriented Software Engineering (OOSE) principles. The system architecture employs the PHP programming language in conjunction with the Laravel framework and a MySQL database. This study demonstrates that utilizing the C4.5 algorithm can enhance the efficiency and effectiveness of the student selection process, reduce errors, expedite data administration, and lead to a more objective student selection process. The method enhances information accessibility for prospective students, consequently augmenting its attractiveness to candidates.

Keywords : System, Classification, C4.5 Algorithm, Selection

INTRODUCTION

The New Student Admission is a procedure for enrolling students in educational institutions, encompassing both formal and non-formal settings. The New Student Admission is a mandatory procedure that every educational institution must follow without exception. The New Student Admission process functions as an educational ecosystem that preserves the continuity of student cohorts, which progressively evolves.

The guidelines for the execution of The New Student Admission are explicitly defined in the Ministry of Education and Culture Regulation No. 51 of 2018. In the subsequent year, these restrictions were amended in the Ministry of Education and Culture Regulation No. 44 of 2019. This refinement underscores the necessity of this activity for all educational institutions, particularly schools.

Vocational High School Piramida Rancaek is one of the institutions that implement The New Student Admission procedure following the conclusion of annual examinations each year. The New Student Admission procedure at Vocational High School Piramida Rancaek follows a conventional method, where prospective students, accompanied by their parents, attend the school to finalize their initial registration, submit the requisite supporting documents, and participate in essential assessments. The outcomes of new student admissions must be more objective and efficient to conserve time, as the existing approaches can yield subjective results and protracted processes.

The New Student Admission system at Vocational High School Piramida Rancaek utilizes a classification method through the

application of the C4.5 algorithm. The C4.5 method generates decision trees from categorization samples. This can be summarised as a decision tree methodology that converts extensive datasets into a decision tree that encapsulates rules.

Prior investigations into data mining in PPDB were conducted by Amelia Yusnita, Siti Lailiyah, and Khoiri Saumahudi, who employed the Naive Bayes method. The researchers determined that the decision support system employing this strategy can facilitate the student selection process in an entirely objective, impartial, and transparent manner in decision-making. A study was undertaken by Linda Monizah Fitriani and Andik Setyono, entitled "Application of the C4.5 Algorithm for New Student Admissions at SD Islam Terpadu Permata Bunda Demak." This study employed RapidMiner software as a modeling tool to build rules for classifying incoming student admissions. The application, designed in the Java programming language, effectively assisted the school in identifying new pupils based on their specific requirements.

Data Mining

Data mining is the procedure of gathering and analyzing data to derive important insights. This is accomplished by software that uses computations, statistics, or artificial intelligence (AI). Multiple factors are driving the ongoing evolution of data mining, including the rapid proliferation of data sets, the storage of data in warehouses that enable nearly all companies to access high-quality databases, and the competitive pressures within the business sector

to enhance market dominance in the global economy.

C4.5 Algorithm

The C4.5 algorithm is an enhancement of the ID3 algorithm, which is utilized for constructing decision trees. CART, C4.5, and ID3 are algorithms employed in the construction of decision trees. (Chen, 2021; Tempola et al., 2022) In the work by Anwar (2025), titled "Application of K-Means and C4.5 Algorithms for dropout risk prediction in vocational high schools," Yan (2022) elucidate the fundamental methodology for constructing a decision tree utilizing the C4.5 algorithm. This approach initiates by designating an attribute as the root, thereafter forming branches for each value. Cases are subsequently allocated to these branches, and the process is reiterated for each branch until all cases within a branch are classified into the same category.

The creation of a decision tree using the C4.5 method Suherman et al., (2023) involves multiple stages:

1. Compiling training data. Training data often originates from previous data that has been categorized into specific classifications.
2. Determining the root of the tree: The supplementary value of each characteristic is computed, with the highest supplementary value designated as the primary root. The supplementary entropy value is subsequently computed using this formula to determine the entropy value:

$$Entropy(S) = - \sum_{i=1}^n p_i * \log_2(p_i)$$

Description:

S = Set of cases

n = Number of partitions S

p_i = Proportion of S_i to S

3. Determine the gain value with the subsequent equation:

$$\text{Gain}(S, A) = \text{Entropy}(S) - \sum_{i=1}^n \frac{|S_i|}{|S|} * \text{Entropy}(S_i)$$

Description:

S = Case set A = Attribute

n = Number of attribute partitions A

$|S_i|$ = Proportion of S_i to S

$|S|$ = Number of cases in S

4. Reiterate steps 2 and 3 until all records are partitioned.
5. The decision tree splitting operation will cease when:
 - a. All records in node N belong to the same class.
 - b. The partitioned records no longer include any properties.
 - c. The vacant branches contain no records.

Classification

The term "classification" derives from the word "classis," which means "to group similar objects" and "to separate dissimilar objects." The classification process is based on four components (Sari & Safii, 2021): Class: This is the dependent variable that is categorical and indicates the "label" of the object. Predictor: This is the independent variable represented by the characteristics (attributes) of the data. Training Dataset: This is a set of data containing values from the two components mentioned above, used to determine the appropriate class based on the

predictor. Testing Dataset: This contains new data that the developed model will classify, and the accuracy of the classification is evaluated. Based on the explanations provided, classification is an activity performed to group or select items that share similarities in order to form a common group.

Framework

According to Yudhanto & Prasetyo, a framework is a collection of libraries or functions that developers may utilize to make it easier for them to code. (Lintang et al., 2022)

Laravel

Laravel is an open-source PHP framework distributed under the MIT license and constructed on the Model-View-Controller (MVC) paradigm. (Abrori et al., 2022) It is a PHP-based web development framework that utilizes the MVC architecture, designed to enhance software quality and minimize maintenance costs. Taylor Otwell created Laravel, recognized as one of the premier PHP frameworks. It is an open-source web development framework characterized by its attractive syntax and expressive code. Laravel is engineered to expedite and streamline web development. (Daulay et al., 2022)

UML

The Unified Modelling Language (UML) is a dependable modeling tool utilized in the creation of object-oriented systems. (Sulistiani & Aldino, 2020) UML is an amalgamation of modeling languages created by Booch, Object Modelling Technique (OMT), and Object-Oriented Software Engineering (OOSE). This approach renders the analysis and design process iterative,

encompassing the identification of classes and objects, the elucidation of the semantics of the relationships among these entities, and the specification of interfaces and implementations (Aji & Sunyoto, 2020; Muhammad & Rahardja, 2021).

¹⁷ The author aims to investigate the implementation of the C4.5 algorithm for classifying new student admissions at Piramida Rancaekkek Vocational School.

METHOD

Research methods

The author utilized two primary approaches for data collecting in this study: observation and interviews. Observation involves collecting data through scrutiny of subjects in their natural habitat, allowing the researcher to document genuine behaviors and interactions. Conversely, interviews occur when the researcher gathers data by posing questions to various individuals, directing inquiries toward a set of participants to elicit their responses. Collectively, these methodologies offer an exhaustive framework for comprehending the research subject.

System Development Methods

Object-Oriented Software Engineering (OOSE) is an object modeling methodology established by Ivar Jacobson in 1992. It is the inaugural object-oriented design technique to employ use cases to enhance software design. A use case delineates a scenario illustrating user interactions with the product or system under development. This approach emphasizes use cases. OOSE has three fundamental stages: the development of requirement and analysis

models, design and implementation, and model testing. The value of this method lies in its ease of learning, as it encompasses all elements of software engineering and utilizes straightforward notation.

RESULTS AND DISCUSSION

C4.5 Algorithm Analysis

It serves for categorization or categorization and possesses predictive characteristics. ¹³ The C4.5 algorithm is a data mining technique that classifies data, designed to uncover significant patterns within large datasets. The execution of the C4.5 algorithm for ascertaining new student admittance adheres to the following procedures:

1. Literature Study

At this juncture, the concepts requisite for the research will be elucidated, including an exposition of the C4.5 algorithm and its implementation methodology.

2. Data Sample Collection

At this juncture, the procedure for gathering sample data will involve soliciting information regarding potential new students for the 2024/2025 academic year from Vocational High School Piramida Rancaekkek. This prospective student dataset encompasses diverse information, including names, originating schools, parental names, selected majors, and more attributes to be analyzed using the C4.5 algorithm. The overall dataset comprises 133 records of prospective pupils. Table 1 below displays several sample data entries that the author will present in this publication.

Table 1. Data on Prospective Students for Vocational High School Piramida 2024/2025

Prospective Students	Interest-Aptitude Test	Psychometric Test	Numerical Test	Major Interests	Status
Student 1	Competent	Quite Competent	Quite Competent	TPK	Passed
Student 2	Competent	Competent	Quite Competent	TPK	Passed
Student 3	Competent	Competent	Competent	TPK	Passed
Student 4	Competent	Not Yet Competent	Not Yet Competent	TPK	Did Not Pass
Student 5	Quite Competent	Quite Competent	Quite Competent	TPK	Passed
Student 6	Not Yet Competent	Competent	Not Yet Competent	TPK	Did Not Pass
Student 7	Quite Competent	Competent	Competent	TEI	Passed
Student 8	Competent	Quite Competent	Quite Competent	TEI	Passed
Student 9	Competent	Competent	Competent	TEI	Passed
Student 10	Competent	Competent	Competent	TEI	Passed
Student 11	Quite Competent	Not Yet Competent	Not Yet Competent	TEI	Did Not Pass
Student 12	Not Yet Competent	Quite Competent	Not Yet Competent	TEI	Did Not Pass
Student 13	Competent	Competent	Quite Competent	LPS	Passed
Student 14	Competent	Competent	Competent	LPS	Passed
Student 15	Quite Competent	Quite Competent	Quite Competent	LPS	Passed
Student 16	Quite Competent	Competent	Quite Competent	LPS	Passed
Student 17	Competent	Not Yet Competent	Not Yet Competent	LPS	Did Not Pass
Student 18	Quite Competent	Not Yet Competent	Not Yet Competent	LPS	Did Not Pass

Data Sample Analysis

Upon acquiring the prospective student data, the qualities are delineated and computed according to the predetermined parameters to ascertain the entropy and gain values. The property with the maximum gain value is chosen

as the root. The subsequent table presents the computations of entropy and gain values for each variable, derived from the data in Table 1, utilizing the C4.5 algorithm for the prospective students of Vocational High School Piramida for the 2024/2025 academic year:

Table 2. Entropy and Gain

		Number of Cases (S)	Passed (S1)	Failed (S2)	Entropy	Gain
Total		133	80	53	0,970064152	
Aptitude Test						0,516054161
	competent	53	44	9	0,657272978	
	quite competent	51	36	15	0,873981048	

		Number of Cases (S)	Passed (S1)	Failed (S2)	Entropy	Gain
Psychometric Test	not yet competent	29	0	29	0	
						0,426514729
	competent	51	36	15	0,873981048	
	quite competent	67	44	23	0,927926262	
Numerical Test	not yet competent	15	0	15	0	
						0,54157362
	competent	36	27	9	0,811278124	
	quite competent	64	53	11	0,661976064	
Major Interests	not yet competent	33	0	33	0	
						0,390806677
	TPK	49	32	17	0,931304369	
	TEI	45	25	20	0,99107606	
	LPS	39	23	16	0,976634911	

The Total Entropy column row in the table above is calculated using the following entropy formula equation:

$$Entropy(S) = \sum_{i=1}^n -p_i \cdot \log_2(p_i)$$

$$Entropy(Total) = \left(-\frac{80}{133} \cdot \log_2\left(\frac{80}{133}\right)\right) + \left(-\frac{53}{133} \cdot \log_2\left(\frac{53}{133}\right)\right)$$

$$Entropy(Total) = 0,970064152$$

Meanwhile, the Gain value in the Interest and Talent Test row is calculated using the following gain formula equation:

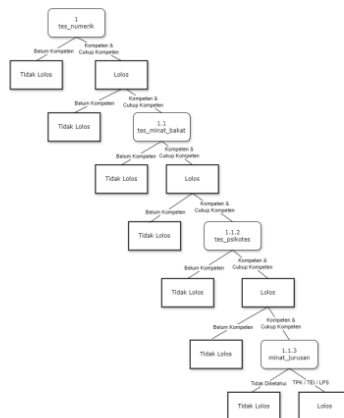
$$Gain(S, A) = Entropy(S) - \sum_{i=1}^n \frac{|S_i|}{|S|} \cdot Entropy(S_i)$$

$$Gain(Total, tes_minat_bakat) = Entropy(Total) - \sum_{i=1}^n \frac{|tes_minat_bakat|}{|Total|} \cdot Entropy(tes_minat_bakat)$$

$$Gain(Total, tes_minat_bakat) = 0,970064152 - \left(\frac{51}{133} \cdot 0,657272979\right) + \left(\frac{51}{133} \cdot 0,873981048\right) + \left(\frac{29}{133} \cdot 0\right)$$

$$Gain(Total, tes_minat_bakat) = 0,516054161$$

The table above indicates that the numeric test variable will serve as the initial node in the decision group due to its superior gain value. Subsequently, the second node is chosen, and this process continues until an identical calculation is employed to derive the tree selection. The resultant decision tree is as follows:



Classification Decision Tree

framework, has yielded a user-friendly the New Student Admission web page for enrolling pupils aspiring to attend Vocational High School Piramida Rancaekek. This system has been developed to facilitate classification functionalities utilizing the C4.5 Algorithm for the New Student Admission committee and personnel. This facilitates a more equitable approach to entering prospective student data and generating reports.

The implementation, utilizing the PHP programming language and the Laravel

The screenshot shows the 'Daftar Akun' (Account Registration) page of the PPDB SMK Piramida system. It features a registration form with fields for 'Nama' (Name), 'Email', 'Password', and 'Confirm Password'. A blue 'Daftar' (Register) button is at the bottom of the form. Below the button, there is a link that says 'Sudah memiliki akun? Masuk' (Already have an account? Login). The page has a light green background and a dark blue header with the text 'PPDB SMK Piramida' and 'Masuk' 'Daftar'.

Figure 2. Account Registration View



Figure 3. Landing Page View

The screenshot shows the 'Login PPDB Online' page of the PPDB SMK Piramida system. It features a login form with fields for 'Email/Username' and 'Password'. A blue 'Masuk' (Login) button is at the bottom of the form. Below the button, there is a link that says 'Sudah memiliki akun? Masuk' (Already have an account? Login). The page has a light green background and a dark blue header with the text 'PPDB SMK Piramida' and 'Masuk' 'Daftar'.

Figure 4. Account Login View



Figure 5. Applicant Dashboard View

Daftar PPDB
 Berikan Data Diri Anda di Aplikasi PPDB SMK Piramida. Setelah itu Anda akan menerima email konfirmasi pendaftaran.

I. IDENTITAS PESERTA DIDIK

NISN
 NIS
 Nama Lengkap
 Nama Belakang
 Tempat Lahir
 Tanggal Lahir
 Jenis Kelamin
 Alamat Rumah
 Email
 Nomor Telepon

II. PENDAFTARAN

Daftar Pendaftaran
 Nomor Pendaftaran
 Alamat Sekolah

III. IDENTITAS ORANG TUA / KAKAK

Nama
 Tempat Lahir
 Tanggal Lahir
 Jenis Kelamin
 Alamat
 Email
 Nomor Telepon

IV. DATA PENDAFTARAN

Daftar Pendaftaran
 Nomor Pendaftaran
 Nomor Pendaftaran
 Nomor Pendaftaran

Figure 6. PPDB Form Display for Applicants



Figure 7. Registrant Logout View



Figure 8. Confirmation of Registrant Logout

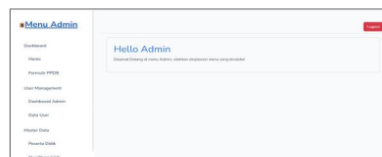


Figure 9. Admin Dashboard View

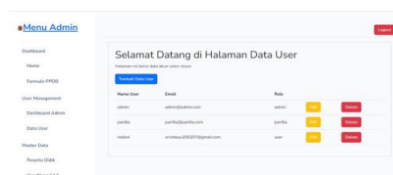


Figure 10. User Data Display

Figure 11. Display of the Add User Data Form

Figure 12. Student Menu Display

Laporan Data Siswa

No	NIK	NISN	Nama Siswa	Jenis Kelamin	Asal Sekolah	Alamat	Nilai Rata-rata
1	320174808051248	0022778124	Purpa Nurfitri M. Kom.	P	SMP 181 Rancaekek	DK. Lareti No. 412, Labuh Rengas 41483, Lampung	Tidak Terhonor
2	3207972960805628	0028305557	Vanny Yusei	L	SMP Lingsi	Jl. Industri No. 345, Padang 27152, Sumatera	Layanan Terhonor
3	32071537546010267	0020229144	Made Wijayanti	P	SMP PGRI Haurpaga	DK. Sireka Kuli Bangor No. 345, Tondok 41745, Sumatera	Tidak Terhonor
4	320475241313353	0023571711	Riko Indrayanto	P	SMP PGRI Haurpaga	Jl. Widad No. 123, Bandar Lampung 40135, Kaldera	Layanan Terhonor
5	320866085654089	0027695621	Anastasia Purpa Winandh	L	SMP PGRI Haurpaga	Jl. Baras No. 176, Tondok 41800, Pulau	Layanan Terhonor
6	3208175114317937	0024877998	Setya Fawwaz M. Fari	L	SMP PGRI Haurpaga	Gg. Padang No. 222, Yogyakarta 40135, Indira	Layanan Terhonor
7	320870329294610	0028236164	Puta Hakim	L	SMP Pemasak Rancaekek	DK. Panjatan No. 395, Marunda 40715, Kaldera	Tidak Terhonor
8	3208875033699318	0029659202	Gilda Oti Laksmirati S.E.	L	SMP 181 Bham	Kl. Jantan Jantar No. 211, Gorontalo 40137, DKG	Tidak Terhonor

Figure 13. Display of Student Report Print Results

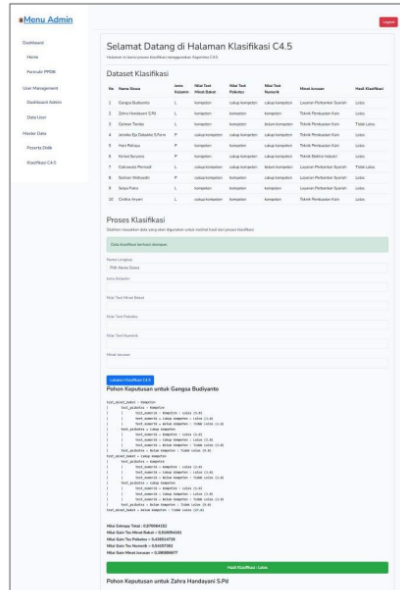


Figure 14. C4.5 Classification Menu Display



Figure 15. Admin and Officer Logout Display

This is a comparative table assessing the effectiveness of the existing system against the proposed system devised by the author:

Table 3 Comparison of Effectiveness Levels

No	Job description	Running System		Proposed System	
		Y/N	Working Process	Y/N	Working Process
1	Registratiomm	☐	60-180 Minute	☐	15 Minute
2	Filling out the Registration Form	☐	30-60 Minute	☐	2-5 Minute
3	The completeness of document	☐	30-60 Minute	☐	2-5 Minute
4	Selection Process	☐	1-2 Sunday	☐	15 Minute

No	Job description	Running System		Proposed System	
		Y/N	Working Process	Y/N	Working Process
5	C4.5 Algorithm Selection Results	☐	-	☐	15 Minute
6	Report	☐	1-4 Sunday	☐	5-15 Minute

CONCLUSION

The system has performed satisfactorily, as anticipated. Testing has verified the efficacy of both input and output, particularly in terms of the precision and effectiveness of the C4.5 classification algorithm. Consequently, this system can aid the school in objectively evaluating students as a decision-making support tool in the new student admission process. Furthermore, the report automation feature improves operational efficiency, expediting and streamlining the new student admission process at Vocational High School Piramida.

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