

PREDICTION OF STUDENTS WORKING ACCORDING TO COMPETENCY WITH THE C4.5 ALGORITMA ALGORITHM

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Abstract

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In this digital era, data is very important to be extracted in order to mine knowledge in it, the resulting data is then used to make preparations, or decisions for the future in order to get the best planning, in universities there are a lot of data that can be mined, one of which is alumni tracer data, alumni tracer data can be used to determine the characteristics of students who work according to their competencies or not by using data mining techniques, the purpose of this study is to determine the characteristics of students who after graduation can work according to their competencies, if these characteristics or criteria can be known well, then the student department can direct students who are actively learning to be able to pursue these criteria so that later these students can work according to their competencies and according to their interests. commitment to produce graduates as superior human resources who work according to their competencies. The stages of this method are collecting data from the alumni tracer questionnaire from STMIK Pelita Nusantara then processing it with data mining techniques, namely data selection, data cleaning, data transformation, then the data is processed by data mining technique classification decision tree algorithm C4.5 then evaluation and simulation with rapid miner to validate manual calculations then build the system and implement the system..

Keywords: Data_Mining; decision_tree; C4.5; Student; Competence; Tracer_Alumni

1. INTRODUCTION

The development of information technology provides benefits in every field, ranging from education, industry, government, research, the world of entertainment, and so on. Primary stakeholders are required to be able to utilize information technology in order to get good results in every plan, action, or decision to be taken, especially in the world of higher education. Universities must be able to maximize the information technology that is currently developing by collaborating with research in order to improve or make policies to improve the quality of the learning process, the development of information technology opens up opportunities for the growth of data collected in large quantities, but not necessarily very large data. can provide value or information, a special container is needed to be able to accommodate, process and extract information from the big data into useful information.

The purpose of this study is to find out the criteria or characteristics of graduates who work according to their competencies based on the results of the alumni tracer which is filled in by alumni from STMIK Pelita Nusantara which is processed with data mining classification techniques, so that it can be very useful information to determine the character or the criteria for students who work according to their competencies or not so that they can be a source of new knowledge for the student department so that they can follow up on the knowledge obtained from the alumni tracer data.

The urgency of this research is to quote a statement from the minister of education, culture, research and technology, Mr. Nadiem Makarim, that 80% of graduates do not work according to competence or outside the sector of their study program, on that basis the Ministry of Education and Culture implements Merdeka Learning Campus Merdeka (MBKM), where students can received more than one discipline, where he stated that there was no work that only relied on one discipline of at least two or sometimes three. (Aisyah – detikEdu, 2021), therefore it is very important to know the criteria of students who work according to competence so that the student affairs department can direct students to optimize the criteria or characters of graduates who work according to their competencies to students

who are in study so that later they can work according to their competence and become qualified human resources.

The data to be processed is the alumni tracer for the 2019 graduate year, 2020 and 2021, tracer data is obtained from the student and alumni section of STMIK Pelita Nusantara through questionnaires to graduates and also tracking to partner companies, then tracer data is processed using data mining techniques as a solution problem solving to obtain information from alumni tracer data, Data mining is defined as the implicit extraction of potential information from a set of data (Muzakir & Wulandari, 2016). The Knowledge Discovery in Database process involves the results of the data mining process (the process of extracting the tendency of a data pattern), then converting the results accurately into information that is easy to understand (Chair et al., 2017), (Farid & Fitrianah, 2021), One of the classification methods data mining is the C4.5 algorithm, the C4.5 algorithm is a method that can create a decision tree based on available training data (fitriani et al., 2021), (Meng, et al 2020). While the decision tree is defined as a method for forecasting, predicting or clarifying (Azwanti, 2018) (Han et al., 2019), this research is relevant to the Research Strategic Plan for Colleges who propose the Informatics Engineering Study Program with a focus on smart application development research.

The previous studies that have been studied by researchers are as follows, Wang, X., Zhou, C., & Xu, X. with title Application of C4.5 decision tree for 2019 scholarship evaluation 2019 Data Used evaluation system at a university in Nanjing, a table was created for the performance of 428 students from 2016 to 2017, who majored in computer science with the criteria: Moral Achievement, Academic Achievement, Sports Achievement, Physical Health and Awards, next there is LumbanGaol N.Y with title Prediction of Potentially Non-Active Students Using Data Mining in Decision Trees and C4.5 Algorithms (2020) Data Used The data analyzed is the data of students of the Triguna Dharma Medan College of Informatics and Computer Management (STMIK) who are active and non-active while the criteria used are Lecture Schedule, Attendance Value, Failed Value, and payment of tuition fees. Research result:

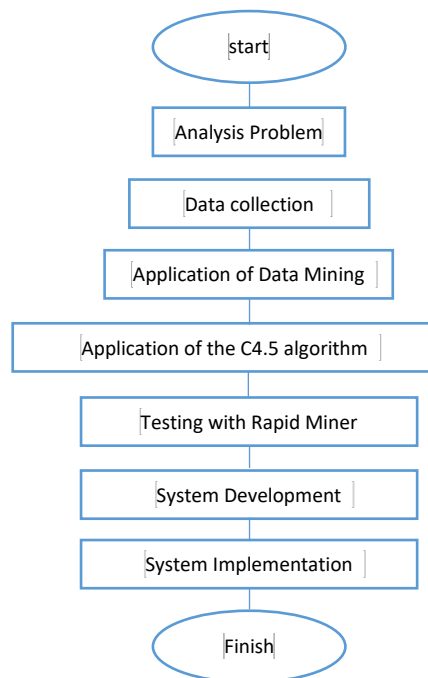
The results obtained are that the resulting rules produce appropriate information in analyzing potentially non-active students. The criteria for non-active students are class schedules, absenteeism scores, failed grades, tuition payments that can affect decisions on active and non-active student status. Research result: This decision tree is accurate enough to evaluate scholarships based on student performance. And after that, a comparison of the C4.5 method with the ID3 method, Fuzzy mathematic, and Set Pair analysis was made with the same data and from the results of the comparison it is known that the C4.5 algorithm gets the best accuracy. And then D. Alverina, AR Chrismanto, and RG Santosa with title Comparison of Accuracy of C4.5 and CART Algorithms in Predicting Category Student Achievement Index 2019 Data Used, student data of the Faculty of Information Technology in 2008-2015, the student data will be categorized based on the admission path, namely the achievement path and the non-achievement path. The achievement path has category attributes (SMU or SMK), status (public or private), location (Java or outside Java), and level (1, 2, 3, or ESP). Non-achievement path have category attributes (SMU or SMK), status (public or private), location (Java or outside Java), level (1, 2, 3, or ESP), numerical value, verbal value, spatial value and analogy value. Research result: The C4.5 and CART algorithms get the same accuracy results for predicting the IP category of new students on the achievement path (non-numeric data), which is 86.86%.

Novelty /Research Novelty: The novelty in this study is that the authors have not found any research to analyze and predict students' work according to competence, as for the selection of the C4.5 method because in many studies the C4.5 method has the best accuracy.

2. METHOD

The methods or stages to achieve the objectives of this research go through the stages from problem analysis, data collection, application of data mining, data processing to the C4.5 algorithm, Testing with Rapid Miner, System Design, System Development, and System Implementation for explanations. More details can be seen in the following image flow chart:





Start

In the early stages of this research, starting from designing and making research proposals and, and it has been completed

Problem analysis

Furthermore, the analysis of the problem, this stage has also been completed where the results of the analysis are poured into the background of the proposal and become the purpose of this research.

Data collection

At this step primary data collection to solve problems and find relevant and up-to-date references there are 3 techniques in collecting this data, namely:

Literature review

This library study was conducted to search for the right theoretical basis and method for solving problems and making state of the art , by searching for reputable international journals and accredited national journals that have digital object identifiers .

Observation

At this observation stage, we conduct a direct visit to STMIK Pelita Nusantara and look for additional information about the alumni tracer

Interview

This interview stage was carried out during field observations by asking questions and direct interviews with stakeholders (student department) and other related parties.

Application of Data Mining

After the problem analysis is complete and the data has been collected, it is then processed using data mining techniques to get good data, namely data selection, data cleaning, data transformation.

Application of the C4.5 algoritma algorithm

After completing the data transformation process, the normalized data is processed with the C4.5 algorithm to make a decision tree, while the steps for implementing the C4.5 algorithm are Calculating the initial information Entropy of the sample data set S, Calculate the split entropy of the sample data set S, Get information gain from attribute A, Calculate the information gain ratio.



Testing with Rapid Miner Software

After the data mining process and the calculation of the c4.5 algorithm on the data are completed, testing is carried out with rapid miner software with the same data to ensure that the calculations are carried out correctly and become a reference for making the system later.

System Development

System development is carried out to facilitate the use of the system and create a specific system to predict students' work according to competence in the following year

System Implementation

After the system development is complete, the next step is the implementation of the completed system to predict students' work according to competence.

3. RESULT AND DISCUSSION

Data

Every year, universities must conduct an alumni tracer every year to find out whether the alumni have gotten a job for less than 6 months, whether they are entrepreneurship, work, or further studies, then of course find out whether the alumni's work is closely related to their competence, here are the results of the 2021 alumni tracer

Table 1 Table of Tracer Results 2021

NO	Name	Gender	Study Program/Department	Year Passed	the relationship between your field of study and your job?
1	A1	Female	Informatics Engineering	2020	Closely
2	A2	Female	Informatics Engineering	2020	Very Close
3	A3	Female	Informatics Engineering	2020	Very Close
4	A4	Male	Informatics Engineering	2020	Closely
5	A5	Female	Informatics Engineering	2020	Less Close
6	A6	Male	Informatics Engineering	2020	Close
7	A7	male	Informatics Engineering	2020	Close
8	A8	male	Informatics Engineering	2020	Fairly Close
9	A9	male	Informatics Engineering	2020	Very Close
10	A10	male	Informatics Engineering	2020	Not at
11	A11	male	Informatics Engineering	2020	Very Close
12	A12	Female	Informatics Engineering	2020	Very Close
13	A13	Female	Informatics Engineering	2020	Very Close

14	A14	Female	Informatics Engineering	2020	Very Close
15	A15	Male	Informatics Engineering	2020	Fairly Close
65	A65	Male	Informatics Engineering	2020	Very Closely
66	A66	Male	Informatics Engineering	2020	Very Close
67	A67	Female	Informatics Engineering	2020	Closely

After that, look for the alumni criteria values above obtained from the study program section, below, the data will be presented which will be the criteria for students to work according to with competence

Table 2 Student criteria score data

NO	Name	Age	Gender	GPA	Organizational	Competence Communication Competence
1	A1	<25	Female	<3.0	Not	very good
2	A2	<25	Female	3.0 - 3.5	Not Organized	Enough
3	A3	<25	Female	>3.5	Active as Member	Very Good
4	A4	<25	male	>3.5	Active as Chairperson	Very Good
5	A5	<25	Female	3.0 - 3.5	Active as Member of	Sa very good
6	A6	<25	male	3.0 - 3.5	Unorganized	Poor
7	A7	<25	male	>3.5	Active as a leader	Very Good
8	A8	25	male	<3.0	Not organized	well
9	A9	>25	male	3.0 - 3.5	Not organized	well
<	10 A10	male	3.0	- 3.5	Not	moderately
11	A11	<25	male	>3.5	Not	very
12	A12	>25	female	>3.5	Not organized	well
13	A13	female	3.0	- 3.5	Active as Leader	Very Good
14	A14	<25	Female	>3.5	Active as a Member	Very Good

15	A15	<25	male	3.0 - 3.5	Not Organized	Good
65	A65	>25	male	3.0 - 3.5	Not organized well	Good
>	66 A66	male	3.0	- 3.5	Not	Very
67	A67	>25	female	3.0 - 3.5	Not	very

Furthermore, the tracer data and student criteria scores are processed so that they are not widening and focusing on research on the results of data transformation and data processing can be seen in the following table:

Table 3 data transformation

No	Age	Gender	GPA	Organizational	Competence Competency Communication	Work According to Competency
1	Below 25	Male	Over 3.5	Active as Chair	Very Good	Fairly Appropriate
2	Under 25	Male	Under 3	Active as Chairperson	Good	Fairly Appropriate
3	Under 25	Male	3 to 3.5	Not Organized	Good	Fairly Appropriate
4	Above 25	Female	3 To 3.5	Not Organized	Good	Fairly Appropriate
5	Above 25	Female	3 To 3.5	Active as Member	Good	Adequately suitable
6	Under 25	Female	Over 3.5	Active as a Member	Very Good	Sufficiently Suitable
7	Under 25	Male	Over 3.5	Not Ordinary Very	Good	Sufficiently Appropriate
8	Under 25	Female	3 To 3.5	Not Organized	Sufficiently	Appropriate
9	Under 25	Female	3 to 3.5	Not Organized	Good	Fairly Appropriate
10	Under 25	Female	3 To 3.5	Not Organized	Good	Sufficiently Appropriate
11	Under 25	Male	3 To 3.5	Active As Member	Good	Fairly Appropriate

12	Under 25	Male	3 To 3.5	Not Organized	Less	Adequately Appropriate
13	Under 25	Male	3 To 3.5	Active Member As	Very Good	Sufficiently Appropriate
14	Under 25	Female	3 To 3.5	Active Member As	Good	Fairly Appropriate
15	Under 25	Male	3 To 3.5	Active Member As	Good	Fairly Appropriate
16	Under 25	Male	3 To 3.5	Active Member As	Sufficiently	Appropriate
17	Under 25	Male	Over 3.5	Active As Chair	Sufficiently	Appropriate
18	Under 25	Male	3 Up to 3.5	Active Member as	Good	Fairly Appropriate
19	Under 25	Women	Under 3	Not Organized	Less	Appropriate
20	Under 25	Male	Under 3	Not Organized Inadequately	Less	suitable
21	Under 25	Male	3 to 3.5	Unorganized	Under	suitable
22	25	Female	3 to 3.5	Unorganized	Moderately	Incompatible
23	Under 25	Male	3 to 3.5	Active as a Member	Moderately	Inappropriate
24	Over 25	Male Male	3 to 3.5	Unorganized	Moderately	Inadequate
25	Under 25	Male	3 to 3.5	Unorganized	Less	Unsuitable
26	Under 25	Male	3 To 3.5	Active Member As	Moderately	Incompatible
27	Under 25	Male	3 To 3.5	Active Member As	Less	Unsuitable
28	Under 25	Female	3 To 3.5	Unorganized	Less	Appropriate
29	Under 25	Female	3 To 3.5	Unorganized	Less	Unsuitable

30	Under 25	Female	Under 3	Active Member as	Very Good	Appropriate
31	Under 25	Female	3 To 3.5	Active Member As	Very Good	Appropriate
32	Under 25	Female	Over 3.5	Active Member As	Very Good	Appropriate
33	Under 25	Male	Over 3.5	Active As a leader	Very Good	Appropriate
34	Under 25	Male	3 to 3.5	Unorganized	Less	Appropriate
35	Above 25	Male	3 To 3.5	Active As Chair	Good	Appropriate
36	Under 25	Male	Above 3.5	Active Member As	Very Good	Appropriate
37	Above 25	Female	Above 3.5	Active Member as	Good	According
38	Under 25	Female	3 To 3.5	Active Member As	Very Good	Corresponding
39	Under 25	Female	Above 3.5	Active Member as	Very Good	Corresponding
40	Above 25	Male	Above 3.5	Active as Chair	Very Good	Corresponding
41	Above 25	Female	Above 3.5	Active as a Member	Very Good	Appropriate
42	Under 25	Female	3 To 3.5	Active Member As	Very Good	Appropriate
43	Under 25	Female	Over 3.5	Active Member As	Very Good	Appropriate
44	Under 25	Male	Above 3.5	Active Member As	Very Good	Appropriate
45	Above 25	Female	Above 3.5	Active Member As	Very Good	According
46	Above 25	Male	3 To 3.5	Active Member As	Good	According

47	Dibawah 25	Female	Above 3.5	Active as Chair	Very Good	Corresponding
48	Under 25	Female	3 To 3.5	Active Member as	Very Good	Corresponding
49	Under 25	Male	Above 3.5	Active Member As	Good	Corresponding
50	Under 25	Male	3 To 3.5	Active Member As	Good	Appropriate
51	Under 25	Female	3 To 3.5	Active Member As	Good	Appropriate
52	Under 25	Male	Over 3.5	Active Member As	Good	Appropriate
53	Under 25	Female	3 To 3.5	Active Member As	Sufficiently	Appropriate
54	Over 25	Female	3 To 3.5	Not Organized	Very Good	Appropriate
55	Under 25	Female	Above 3.5	Active as Chair	Good	Appropriate
56	Under 25	Male	Over 3.5	Active Member As	Very Good	Appropriate
57	Under 25	Female	3 To 3.5	Active Member As	Good	Appropriate
58	Under 25	Male	Over 3.5	Active As Chair	Very Good	Appropriate
59	Under 25	Female	3 To 3.5	Active Member As	Very Good	Appropriate
60	Under 25	Female	3 To 3.5	Active Member As	San gat Good	Appropriate
61	Under 25	Male	3 To 3.5	Active Member As	Good	Appropriate
62	Under 25	Male	3 To 3.5	Active Member As	Good	Appropriate
63	Under 25	Male	3 To 3.5	Unorganized	Good	Appropriate

64	Under 25	Male	3 To 3.5	Active Member As	Good	According
65	Above 25	Male	3 To 3.5	Not Organized	Good	According
66	Above 25	Male	3 To 3.5	Not Organized	Very Good	According
67	Above 25	Female	3 To 3.5	Not Organized	Very Good	According

C4.5 Algorithm

Next Applying the C4.5 Algorithm To apply the C4.5 Algorithm, the first step is Data Transformation to Find the Entropy and Gain Values.

The formula for the C4.5 algorithm is divided into 2 formulas. To calculate the gain, the formula as shown in equation 1 is used below:

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

Description:

S : Set of cases

A : Attribute

n : Number of partitions attribute A

|S_i| : Number of cases on partition i

|S| : Number of cases in S

Meanwhile, the calculation of the entropy value can be seen in equation 2 below

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

$$\text{Entropy}(\text{Total}) = -1867 \cdot \log_2 1867 + -3867 \cdot \log_2 3867 + -1167 \cdot \log_2 1167$$

$$\text{Total Entropy} = 1.40$$

And so on to find entropy from Age, Gender, GPA, Organizational Competence and Communication Competence

$$\text{Gain}(\text{Age}) = 1.40 - 5467 \cdot 1.46 + 1367 \cdot 0.99$$

$$\text{Gain}(\text{Gain}) = 0.03$$

And so on to look for Gain (Gender, GPA, Organizational Competence and Communication Competence)

Furthermore, complete data on entropy and gain can be seen in the table below

Table 4 Entropy and Gain

Node		Cases	Work			Entropy	Gain
			Sufficiently	Appropriate	Less Appropriate		
Total		67	18	38	11	1.40	
Age							0.03
	Under 25	54	16	28	10	1.46	

	Above 25	13	2	10	1	0.99	
Gender							0.01
	Male	36	11	18	7	1.48	
	Female	31	7	20	4	1.27	
ipk							0.34
	Above 3.5	20	4	16	0	0	
	Under 3	4	1	1	2	1.5	
	3 To 3.5	43	13	21	9	1.49	
Organizational Competence							0.28
	Active as Chairman	9	3	6	0	0	
	Active As Member	37	8	26	3	1.12	
	Unorganized	21	7	6	8	1.57	
Communication Competence							1.40
	Very Good	26	4	22	0		
	Good	24	10	14	0		
	Enough	9	3	1	5		
	Less	8	1	1	6		

Next, look for the Max Gain value, the highest gain will be chosen to find the root in the calculation above, the highest gain is the interaction facility. Therefore, the interaction facility becomes the root (first root)

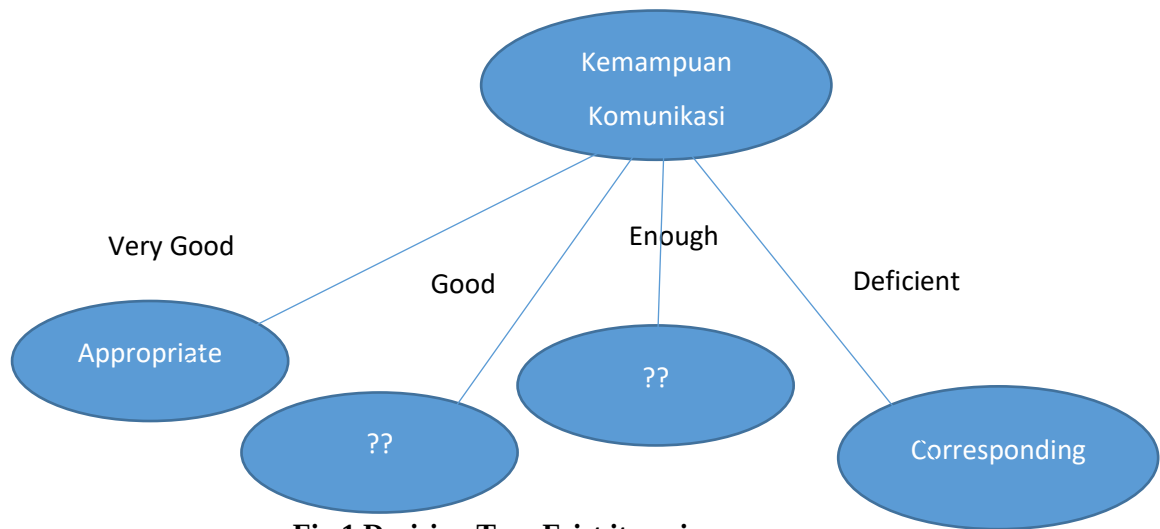


Fig 1 Decision Tree Frist iteration

The decision tree above has not been completed because if the Communication Competency Value is Good and the Communication Competency Value is Good Enough The decision is not known. So the decision has not been obtained, then the calculation is carried out again to iteration 2 specifically for Good and Enough Competency Values. And the calculation uses the rapid miner model to find out the full decision tree as shown in the following figure:

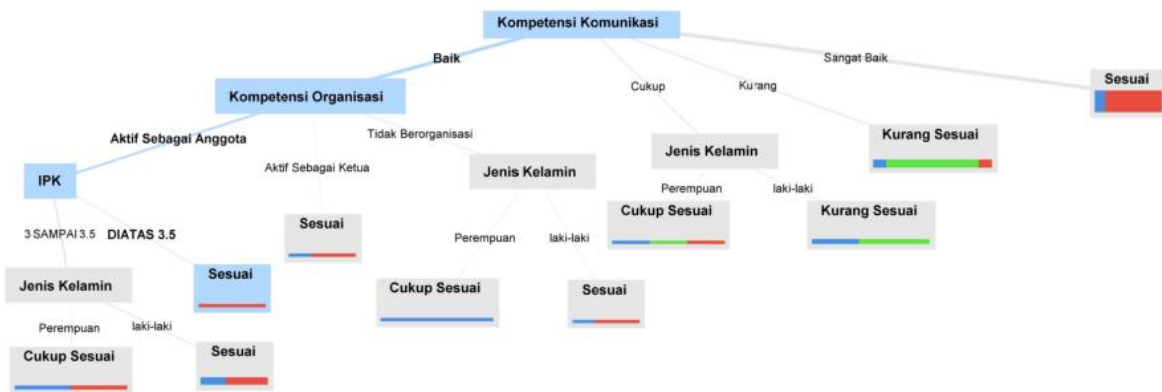


Fig 2 Decision Tree

Data requirements

The rules and information obtained from the results of the decision tree above are as follows:

1. If the Communication Competency Value is very good
2. , then the work is in accordance with the competence
3. . Good Communication Competence and Active Organizational Competence Value as a member and GPA value above 3.5 then the work is in accordance with Competency
4. If the Communication Competency Value is good and Organizational Competence Value is active as a member and GPA value is 3.0 to 3.5 and gender is female then the job is quite in accordance with competence
5. If the Communication Competency Value is good and the Organizational Competence Value is active as a member and the GPA is 3.0 to 3.5 and the gender is male, then the work is in accordance with the Competency

6. If the Communication Competency Value is good and the Organizational Competency Value is active as an employee. Members and GPA values of 3.0 to 3.5 and gender are female then the work is quite in accordance with the competence
7. If the value of communication competence is good and the value of organizational competence is not organized and the gender is male then the work is in accordance with the competence
8. if the value of communication competence is good and the value of organizational competence, then the work is quite in accordance with the competence
9. is sufficient and the gender is male, the work is not in accordance with the competence
10. female
11. competenceJobs Are Not In Accordance With Competencies

4. CONCLUSIONS

The conclusion of this study is that alumni tracer data can be used as information to predict students' work according to competence or not with the help of the C4.5 algorithm which produces rule information or rules. students work according to competence or not based on available data driven.

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