Research Article

Career Prediction of Informatics Engineering Alumni Using Naïve Bayes Algorithm

[1,*]Nurkholis, [2]Andri Nofiar. Am

[1,2] Logistics Technology Study Program, Kampar Polytechnic, Kampar Regency, Riau 28463, Indonesia

* Corresponding Author: Nurkholis11151996@gmail.com

Abstract: Alumni are an important part of education, especially in higher education where alumni can be a reference for the quality of the majors, the more alumni graduates who can get jobs in accordance with their majors, the better the teaching and learning process in the majors, but if the opposite happens, the university needs to evaluate the teaching and learning process so that the students produced can keep up with the times, during the process of finding work in accordance with the alumni's majors. Uin Suska Riau informatics engineering alumni are no exception where analyzing alumni careers is important to be able to improve the quality of Uin Suska Riau in producing alumni who are able to compete in the future. The Naïve Bayes algorithm is a branch of machine learning that can make predictions using classification techniques in predicting the career data of informatics engineering alumni. In the study there was alumni data to carry out the prediction process on career suitability with majors using 275 data and divided into training data and testing data resulting in an accuracy of 75%.

Keywords: Alumni, Prediction, Naïve Bayes, Machine Learning, Accuracy

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1. Introduction

Information technology is one of the fields that is increasingly advanced and growing rapidly, the development of technology can be seen in everyday life, be it in the form of abundant data or information starting from the industrial, economic and other sectors [1]. Artificial intelligence (AI) is an instruction related to how to make computers do better or even smarter than humans [2].

Machine learning is a branch of artificial intelligence. Machine learning is the implementation of disciplines in the form of data, statistics, mathematics and programming simultaneously, using algorithms to extract data into knowledge to be able to formulate predictions on data [3]. One of them is the Naïve Bayes algorithm, the initial stage of Naïve Bayes requires an initial dataset for training to produce a decision [4].

College alumni need to evaluate programs to reduce "unsuitable graduates in their fields". Universities, especially in majors, are worried if their students take the wrong and inappropriate studies [5]. Alumni are very important in improving the quality of higher education, both in learning and teaching activities [6]. Universities have their own strategies in improving the quality of their student graduates to be accepted in the world of work [7]. SKKNI Kemenaker RI No. 183 of 2016 in the field of professional administration. Work competencies are set by the Indonesian government through the ministry, so that every worker in Indonesia occupies the right field of work and in accordance with their competencies. The data used comes from informatics engineering, faculty of science and technology, Uin Suska Riau. Alumni can be an important indicator of the quality of education, every university is obliged to provide quality education for its graduates in order to create human resources that have competitiveness [8].

Based on previous research in using the Naïve bayes algorithm about related research [9] predicting Naïve bayes in money laundering results in 81% accuracy. Research [5] predicts the careers of tafsir and hadith alumni using Naïve bayes modeling and Decision tree with an accuracy value of 97.1% and 92.6%. Research conducted [10] using Naïve Bayes for the classification of new student candidates resulted in an accuracy of 73%. Literature review [11] Naïve bayes can provide excellent results that are clear and impressive to the final results of the research done. Research [12] using Naïve Bayes predicts hepatitis patients with an accuracy rate of 83.71%. Another study [13] Naïve bayes classification of liver disease resulted in 60% accuracy. Research [14] uses Naïve bayes in the classification of liver disease with 83.1% accuracy. Research conducted by [15] classifying articles using Naïve bayes resulted in 71% accuracy. Research [16] classification of new students with Naïve bayes resulted in 76.67% accuracy.

Naïve Bayes is one of the 10 algorithms that have the best ranking in forming decisions. Naïve Bayes itself is a probabilistic research [17]. Research conducted [7] for predicting alumni waiting time with 68% accuracy. Another research [18] used Naïve Bayes using 90:10 test data with an accuracy rate of 88.89%. Research by [19] uses Naïve bayes for predicting cash assistance recipients with 96% results. Research conducted [20] uses Naïve Bayes to determine sleep disorders with an accuracy rate of 71%. Peneltiain by [21] predictions using Naïve bayes in determining patient recovery by 98.14%. Research conducted [22] predicts student graduation using Naïve Bayes with an accuracy rate of 88.16%. Research conducted [23] determines the poor using Naïve bayes with an accuracy of 96.63%. Peneltian [24] Prediction of drug users in the city of pagar alam with perfect accuracy.

Based on the description that has been explained and reviewed, research is carried out on designing an alumni career prediction system using the Naïve bayes algorithm in informatics engineering Uin Suska Riau. The purpose of this research is to help the department in reducing graduates who are not suitable for their fields.

2. Method

To be able to complete the research, the research was carried out in several stages starting with a research design that was used as a guideline reference. This step can be seen in Figure 1.

2.1 Problem identification

The first stage carried out by the author is to carry out a general problem identification process, meaning that the research is carried out to solve a problem raised in the research process.

2.2 Formulating the Problem

This stage is to understand the scope and limits of the research carried out on the alumni career prediction process. Formulating is done to determine the objectives in the research in the form of a system that can determine the suitability of alumni careers in their field of work.

2.3 Determining Goals

At the stage of the goal where after the problem analysis has been determined, it can make the research exactly what is aimed at the final process later and make a solution.

2.4 Literature study

The stage of literature conducted by the author is to read about the writing of previous works (state of art) which is the basis for guidelines in research related to machine learning or more precisely about the algorithms used.

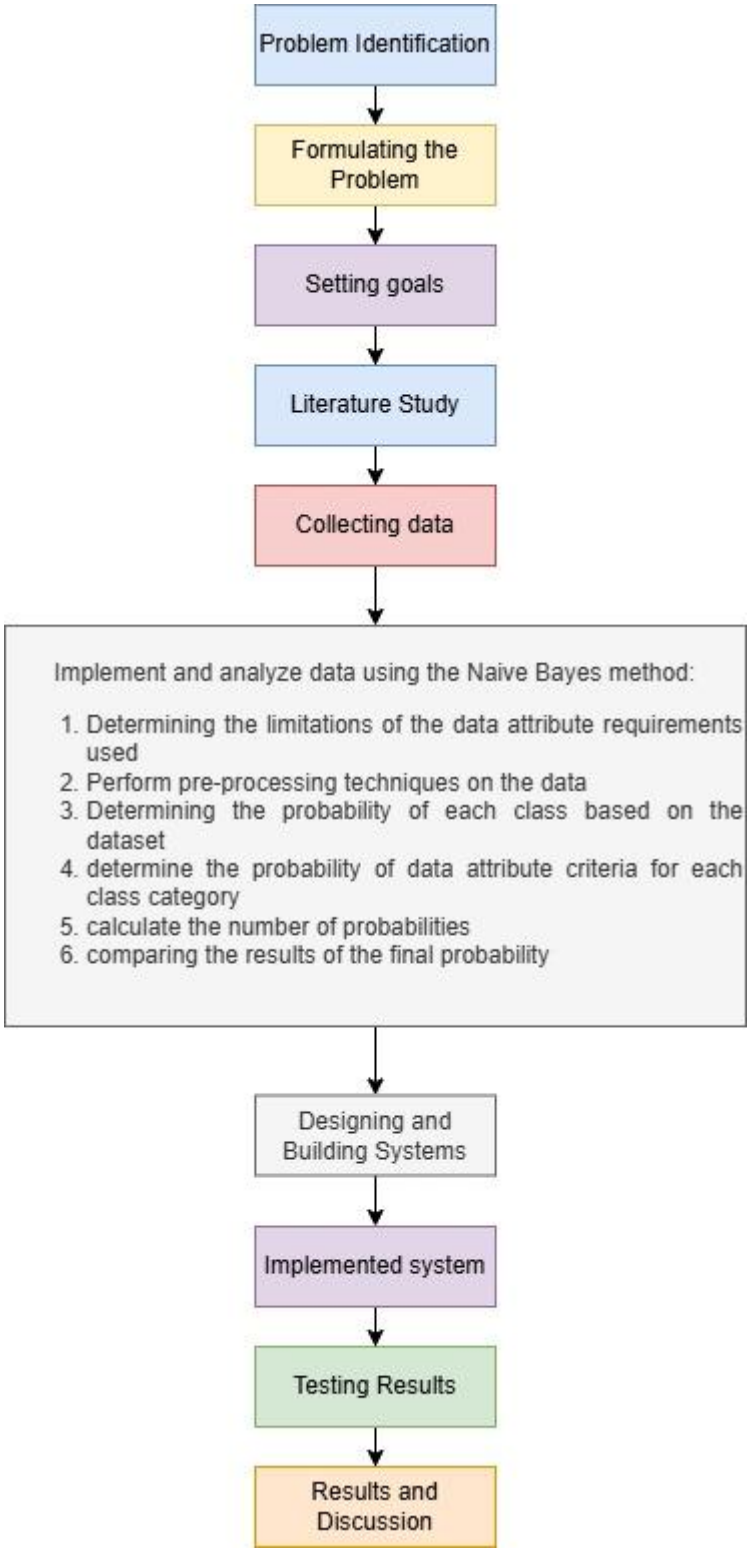

Figure 1. Flowchart System

2.5 Data Collection

The process of collecting data and data criteria needed during the research process, in data collection techniques researchers will use information collection methods that contain facts that exist in the field during the research process.

2.6 Implementation and analysis of Naïve Bayes algorithm

At this stage data that is finished to be processed will be analyzed and classified using the method based on the provisions in the Naïve Bayes algorithm, which can be seen as follows:

$$P(H \mid X)=(P(X|H)P(H))/(P(x)) \quad (1)$$

Description:

X : Data from unknown classes
H : Hypothesis X special class
$P(H|X)$: Probability of H condition X
$P(H)$: Probability H
$P(X|H)$: Probability X based on the conditions in the hypothesis
H $P(X)$: Probability of X

From the formula that has been determined in the naïve Bayes algorithm, the stages of the naïve Bayes algorithm process are as follows:

- Calculating the number of classes or target labels
- Calculating the number of attribute cases per class
- Multiplying the entire number of class probabilities
- Comparing the final probability results

The following is a table of target classes from Naïve Bayes prediction research in determining career predictions for informatics engineering alumni.

Table 1. Class Label Prediction

No	**Class Labels**	**Career**
1	Information Technology (IT)	Match
2	Non-Information Technology	Not suitable

2.7 Design and build the system

At this stage, the author designs the needs to build the application and designs the application to be made based on the previous stages. The application system is used to perform reasoning on alumni data following the field of study work of college graduates.

2.7.1 UML Modeling

UML stands for (Unified Modeling Language) which is an object-oriented object consisting of use cases, class diagrams, and activities.

2.7.2 Use case

Use case diagrams are used to model a system, and use cases are actor interactions with the system.

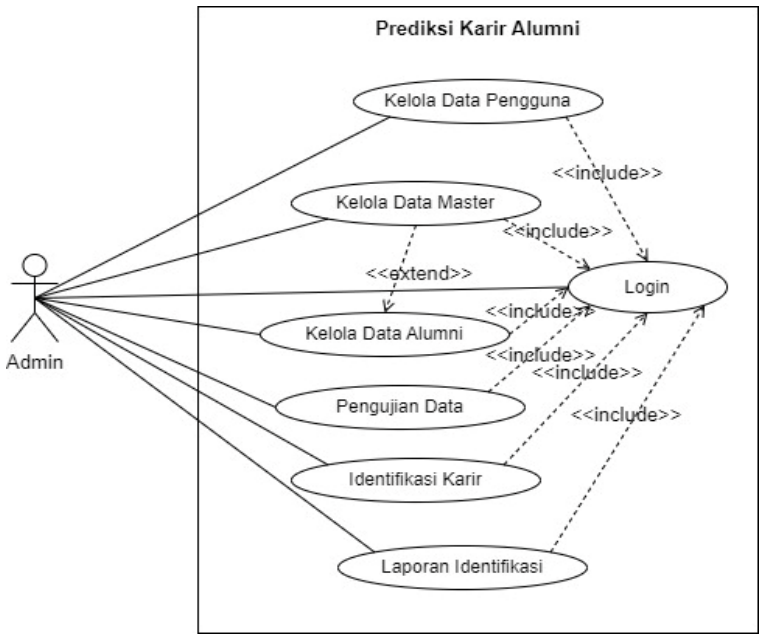

Figure 2. Use Case Diagram

2.7.3 *Class diagrams*

A class diagram is a system modeling that describes the structure of classes and relationships with other classes.

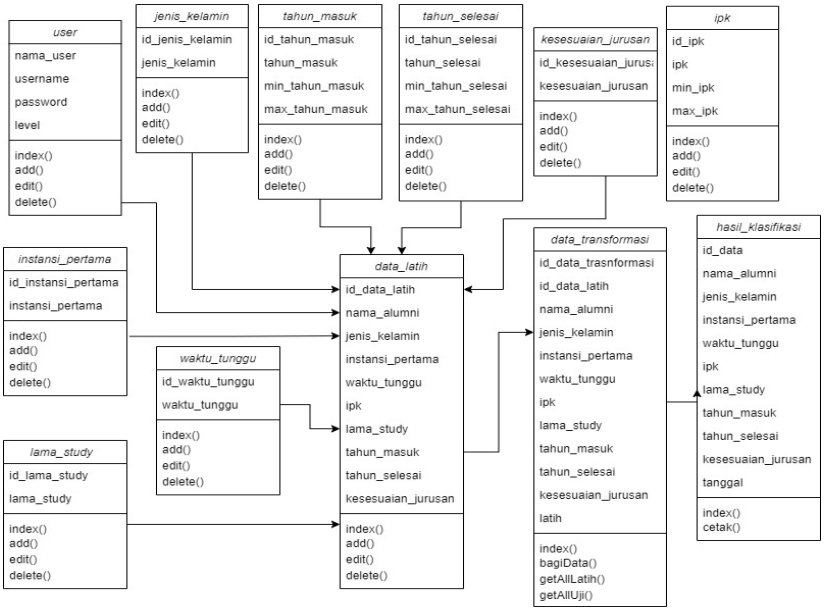

Figure 3. Class Diagram

2.7.4 *Activity diagram*

Activity diagram to describe the flow of events in the use case aims to make it easier to describe the flow of a process, following the process of managing master data.

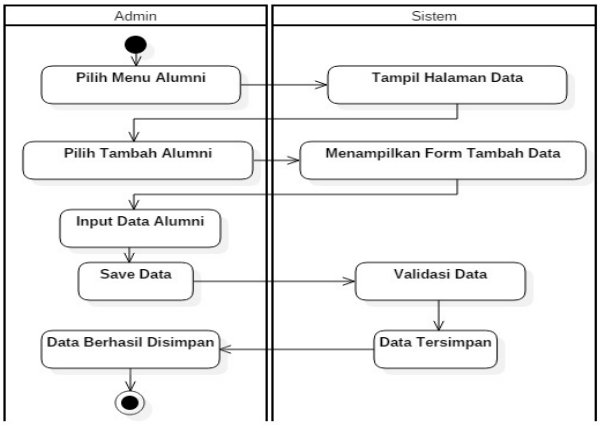

Figure 4. Activity Diagram

2.8 System implementation

Identifying the results of the naive Bayes algorithm in determining alumni career predictions, the data used as training and test data will be processed at this stage.

2.9 Testing Results

Testing the results or improvements from research is done in the form of a system that is made, with the needs that have been planned before. Testing the results is made to prove the research process in an application.

2.10Results and Discussion

Results and discussion are a way to find out whether the Naïve Bayes algorithm studied is following expectations for determining alumni career predictions that can be concluded in the form of results and evaluation of the accuracy level of the system that will become knowledge.

3. Result and Discussion

3.1 Data Analysis

The data analyzed aims to be able to classify predictions of career compatibility in the field of work with majors so that the results of the analysis can be a reference in making a decision, as described above the algorithm chosen is the Naïve Bayes algorithm. The dataset totals 275 data and two class labels which can be seen in Table 2.

Table 2. Alumni Career Data

No	Gender	Year of Entry	Year Completed	Study	GPA	Waiting time	First Agency of Employment	Work sector
1	Male	1999	2004	5 years 0 months	3,18	1 Month	Local Government	Non-Information Technology
2	Male	1999	2004	4 years and 8 months	3	6 Month	National private	Information Technology (IT)
3	Female	1999	2004	4 years and 2 months	3,15	2 Month	Ministry/Agency	Information Technology (IT)
4	Male	1999	2004	5 Years	3,01	3 Month	National private	Information Technology (IT)
5	Female	1999	2004	5 years	2	1 - 2 Th	Ministry/Agency	Non-Information Technology
…	…	…	…	…	…	…	…	…
271	Male	2014	2019	5 Years 4 Months	3,39	6 Month	National private	Information Technology (IT)

No	Gender	Year of Entry	Year Completed	Study	GPA	Waiting time	First Agency of Employment	Work sector
272	Female	2012	2017	4 years and 6 months	3,3	7 - 11 Month	National Foundation/NGO	Information Technology (IT)
273	Male	2009	2016	6 Years	3,37	1 Month	Self-employed	Information Technology (IT)
274	Male	2010	2015	4 years and 9 months	3,25	1 Month	Private education foundation	Information Technology (IT)
275	Male	2010	2017	7 years	3,01	1 Month	National private	Information Technology (IT)

3.2 Identifying the Dataset

The research dataset is converted into transformed data where the data label or target data for career suitability is appropriate and inappropriate. The amount of data is 275 which has attributes or features that describe each sample or instance. From what has been obtained in the research, only 10 data are displayed. The list of alumni data can be seen in Table 3.

Table 3. Data Training

Gender	Year of Entry	Year Completed	Length of Study	GPA	Waiting Time	First Agency	Major Suitability
Male	1999 - 2004	2004 - 2009	5 Years	Good	1 – 6 Months	Negeri	Not appropriate
Male	1999 - 2004	2004 - 2009	5 Years	Enough	1 – 6 Months	Swasta	Aligned
Female	1999 - 2004	2004 - 2009	4 Years	Good	1 – 6 Months	Negeri	Aligned
Male	1999 - 2004	2004 - 2009	5 Years	Good	1 - 6 Months	Swasta	Aligned
Female	1999 - 2004	2004 - 2009	5 Years	Enough	13 - 18 Months	Negeri	Not appropriate
…	…	…	…	…	…	…	…
Male	2011 - 2016	2016 - 2021	5 Years	Good	1 - 6 Months	Swasta	Aligned
Female	2011 - 2016	2016 - 2021	5 Years	Good	7 - 12 Months	Negeri	Aligned
Male	2005 - 2010	2016 - 2021	6 Years	Good	1 - 6 Months	Swasta	Aligned
Male	2005 - 2010	2010 - 2015	5 Years	Good	1 - 6 Months	Swasta	Aligned
Male	2005 - 2010	2016 - 2021	7 Years	Good	1 - 6 Months	Swasta	Aligned

The results of the dataset are processed into 90 training data. From the total alumni data totaling 275 data, the results of testing data amounted to 28 data and 247 data training data. The purpose of dividing test data and training data is useful for determining data that will be used as Naïve Bayes algorithm training data and testing data in the process of determining prediction results using the Naïve Bayes algorithm.

Table 4. Data Testing

Gender	Year of Entry	Year Completed	Length of Study	GPA	Waiting Time	First Agency	Major Suitability
Male	1999-2004	2004-2009	5 Years	Good	1-6 Months	Country	**?**
Female	1999-2004	2010-2015	5 Years	Very good	1-6 Months	Private	**?**
Male	1999-2004	2004-2009	5 Years	Very good	13-18 Months	Country	**?**
Male	1999-2004	2004-2009	7 Years	Good	1-6 Months	Private	**?**
Male	2005-2010	2010-2015	5 Years	Good	1-6 Months	Private	**?**

The testing data will be processed using manual calculations in Microsoft Excel and processed manually with the Naïve Bayes algorithm process and the next process is the calculation process using a web-based system.

4. Result and Discussions

4.1 Naïve Bayes Calculation Results

The calculation process of the Naïve Bayes algorithm to solve the problems in the research is described in the following process:

4.1.1 Calculate the number of classes or target labels.

Counting the number of classes is the first stage in Naïve Bayes, summing the data with each class and then dividing by the total data in that class.

Table 5. Calculating Class

Class(Y)	Total	Result P(Y)
P Appropriate	175/247	0,708502024
P Not suitable	72/247	0,291497976

4.1.2 Calculating the number of attribute cases per class

The second process is the calculation of data attributes in each class by summing the probability of data against the target class as follows:

a. Gender

The completion of the likelihood for gender can be seen in Table 6.

Table 6. Gender Probability

Gender Probability	Total	Results
P JK=Female|Class=Fit	48/175	0,274285714
P JK=Female|Class=Not Suitable	15/72	0,208333333
Gender Probability		
P JK=Male|Class=Suitable	127/175	0,725714286
P JK=Male|Class=Mismatched	57/72	0,791666667

b. Entry Years

The solution for the likelihood of Years entered by alumni can be seen in Table 7.

Table 7. Probability of Year Entered

Probability of Years Entered	**Total**	**Results**
P TM=1999 - 2004|Class=Suitable	28/175	0,16
P TM=1999 - 2004|Class=Not Suitable	19/72	0,263888889
Probability of Years Entered		
P TM=2005 - 2010|Class=Suitable	67/175	0,382857143
P TM=2005 - 2010|Class=Nonconforming	29/72	0,402777778
Probability of Years Entered		
TM=2011 - 2016|Class=Suitable	79/175	0,451428571
TM=2011 - 2016|Class=Nonconforming	24/72	0,333333333
Probability of Years Entered		
TM=2017 - 2022|Class=Suitable	2/175	0,011428571
TM=2017 - 2022|Class=Not Suitable	0/72	0

c. Year Completed

The likelihood results of Years completed by alumni can be seen in Table 8.

Table 8. Probability of Years Completed

Probability of Year of Completion	**Total**	**Results**
P TT=2004 - 2009|Class=Suitable	24/175	0,137142857
P TT=2004 - 2009|Class=Nonconforming	15/72	0,208333333
Probability Year of Graduation		
P TT=2010 - 2015|Class=Suitable	72/175	0,411428571
P TT=2010 - 2015|Class=Nonconforming	27/72	0,375
Probability Year of Graduation		
P TT=2016 - 2021|Class=Suitable	79/175	0,451428571
P TT=2016 - 2021|Class=Not Suitable	30/72	0,416666667

d. Length of Study

The results of the likelihood of the length of study of alumni can be seen in Table 9.

Table 9. Probability of Duration of Study

Probability of Length of Study	**Total**	**Results**
P LS=4 Years|Class=Appropriate	30/175	0,17142857
P LS=4 Years|Class=Not Suitable	9/72	0,125
Probability of Length of Study		
P LS=5 Years|Class=Suitable	68/175	0,38857143
P LS=5 Years|Class=Not Suitable	29/72	0,40277778

Probability of Length of Study	**Total**	**Results**
Probability of Length of Study		
P LS=6 Years|Class=Suitable	40/175	0,22857143
P LS=6 Years|Class=Not Suitable	14/72	0,19444444
Probability of Length of Study		
P LS=7 Years|Class=Appropriate	37/175	0,21142857
P LS=7 Years|Class=Not Suitable	20/72	0,27777778

e. GPA

The likelihood results of alumni GPA getting a job are in Table 10.

Table 10. GPA Probilites

GPA Probilites	**Total**	**Results**
P GPA=Excellent|Class=Appropriate	30/175	0,17142857
P GPA=Very Good|Class=Not Suitable	9/72	0,125
GPA Probilites		
GPA=Good|Class=Appropriate	95/175	0,54285714
P GPA=Good|Class=Not Suitable	42/72	0,58333333
GPA Probilites		
P GPA=Sufficient|Class=Appropriate	51/175	0,29142857
P GPA=Sufficient|Class=Not Suitable	21/72	0,29166667

f. Waiting Time

The results of the likelihood of waiting time for alumni to get a job are shown in Table 11.

Table 11. Probability of Waiting Time

Probability of Waiting Time	**Total**	**Results**
P WT=1-6|Class=Appropriate	158/175	0,90285714
P WT=1-6|Class=Not Suitable	63/72	0,875
Probability of Waiting Time		
WT=7 - 12|Class=Fit	11/175	0,06285714
P WT=7 - 12|Class=Not Suitable	7/72	0,09722222
Probability of Waiting Time		
WT=13-18|Class=Suitable	7/175	0,04
P WT=13-18|Class=Not Suitable	2/72	0,02777778
Probability of Waiting Time		
P WT=19-24|Class=Fit	0/175	0
P WT=19-24|Class=Not Suitable	0/72	0

g. Work Agency

The results of the likelihood of the institution where the alumni got a job are in Table 12.

Table 12. Work Agency or Instance probability

Instance probability	**Total**	**Results**
P Company=State|Class=Suitable	99/175	0,565714286
P Company=State|Class=Not Appropriate	31/72	0,430555556
Company Probability		
P Company=Private|Class=Suitable	76/175	0,434285714
P Company=Private|Class=Not Suitable	41/72	0,569444444

4.2 Multiply the sum of all class probabilities.

The next process is to multiply all the attributes that correspond to the class.

Table 13. Calculation Result Table

No	**Test Data**	**As per**	**Not suitable**
1	Test data 1	0.00121554	0.00112299
2	Test data 2	0.00032298	0.00015075
3	Test data 3	1.64395E-5	7.63941E-6
4	Test data 4	0.00050774	0.00102431
5	Test data 5	0.00669867	0.00408052

4.3 Comparing final probability results

The highest inter-class probability result will be selected as the prediction result. The class comparison results can be seen as following Table 14.

Table 14. Class Comparison Results

No	**Test Data**	**Class Result**	**Target Class**
1	Test Data 1	As per	As per
2	Test Data 2	As per	Not suitable
3	Test Data 3	As per	As per
4	Test Data 4	Not suitable	Not suitable
5	Test Data 5	As per	As per

4.4 Application Testing Results

4.4.1 Login Page

Here is the login page of the system in Figure 5. This page serves to be able to enter the system homepage, users are required to fill in a password and username if it is correct then it will be transferred to the system homepage.

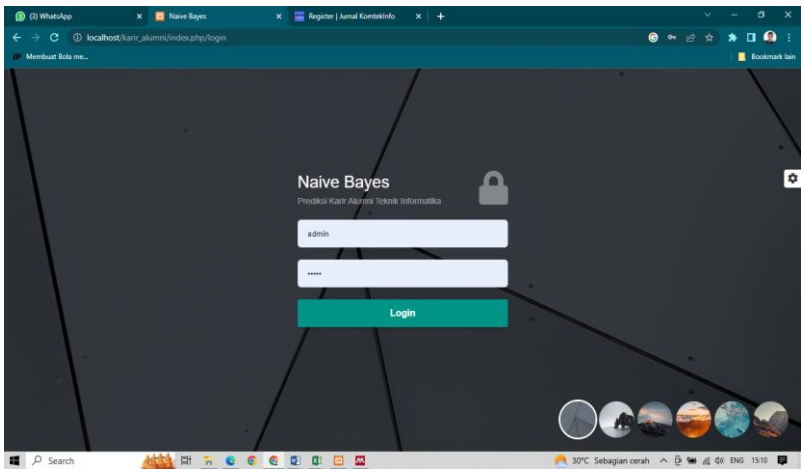

Figure 5. Login Page

4.4.2 Alumni Data Page

Figure 6 is the training data page which will be transformed by the system to become training data to get predictions. From alumni data, calculations between system calculations and manual calculations can later be compared.

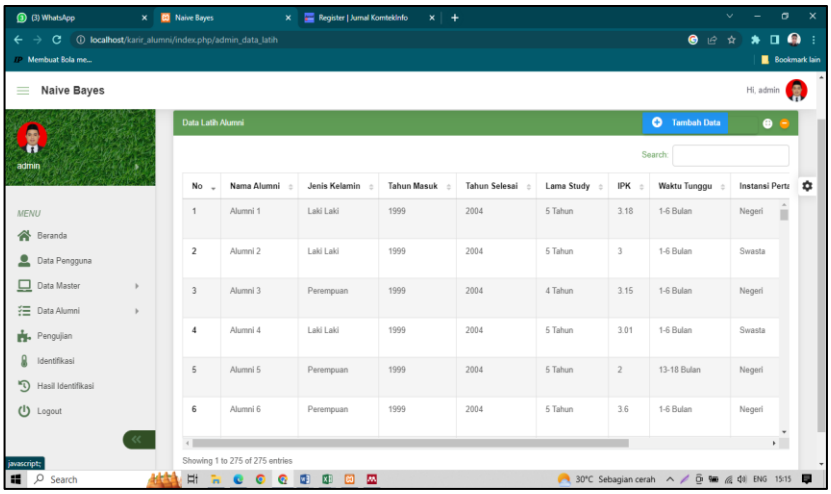

Figure 6. Data Alumni

4.4.3 Testing Page

Furthermore, Figure 7 is the stage where the testing data will be tested using the existing training data with the Naïve Bayes algorithm as has been done in the manual calculation in the previous stage.

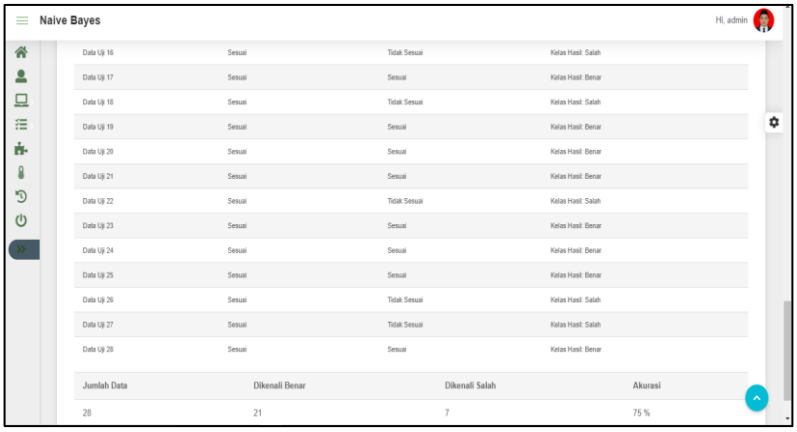

Figure 7. Prediction Result Page

Finally, in the calculation of the sample data tested the results are the same as the system that has been tested in other words the results of manual calculations with the system built have the same results in predicting the careers of Uin Suska Riau informatics engineering alumni and getting 75% prediction results.

5. Conclusion

Based on the research conducted, the following conclusions can be drawn: [1] The Naïve Bayes algorithm built using a web-based system is capable and can predict the career data of informatics engineering alumni at Uin Suska Riau. [2] The test results of the training data on Uin Suska Riau informatics engineering alumni that have been carried out, using the Naïve Bayes algorithm based on the division and training data compared to the 28 test data given, obtained results of 75% in predicting alumni careers.

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Conflicts of Interest: The authors declare no conflict of interest.
Additional Information: No Additional Information from the authors.

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