16. Prediction_of_Student_Satisfaction_with_Academic_Services_Using_Naive_Bayes_Classifier.pdf

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Prediction of Student Satisfaction with Academic Services Using Naive Bayes Classifier

Budi Sunarko, Uswatun Hasanah, Ulfah Mediaty Arief, Feddy Setio Pribadi, Syafira Tantri Istikomah,
Agung Adi Firdaus, Alifa Mauludyah Dzukha
Department of Electrical Engineering, Faculty of Engineering,
Universitas Negeri Semarang
Semarang, Indonesia
budi.sunarko@mail.unnes.ac.id, uswatun_hasanah@mail.unnes.ac.id, ulfahmediatyarief@mail.unnes.ac.id,
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alifa.mauludyah.dzukha.x.tkj3@students.unnes.ac.id

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***Abstract*—Academic service is an academic activity offered to a party (student) either directly or indirectly in the context of achieving academic goals. Student satisfaction as users of educational services is very important for the progress of a university. This is because student satisfaction will have an impact on their loyalty to the university. The prediction of student satisfaction is an important factor that determines the quality of a university. Data mining can optimize the process of finding information in large databases and finding previously unknown patterns. The method used is a prediction with a Naive Bayes Classifier using 85 datasets obtained from surveys using the SERVQUAL scale. There are 4 different experiments in datasets distribution for training and testing to find the best distribution. The best distribution result is 75% for training and 25% for testing with 95% accuracy. Research on predicting student satisfaction with academic services at the study program of PTIK of UNNES using the Naïve Bayes classification method produces a good model and website application that predicts student academic service satisfaction with an accuracy value of 95% and it is concluded to be a very good classification model.**

Keywords*— *Data Mining, Prediction, Academic Services, Naive Bayes

I. Introduction

Human resource development is significantly correlated with education services. Furthermore, developing areas both local and global are potentially supported by universities local and global- are potentially supported by universities [1]. Public awareness of higher education also raises demands from the community for the quality of higher education. Sustainability goals in higher education will not be achieved without the cooperation and participation of stakeholders, namely administrative staff, lecturers, students, funding bodies, entrepreneurs, and communities [2]. Universities as a form of higher education must provide satisfactory services that can meet the needs of students. Universities, as tertiary education, must provide satisfactory services covering student activities.

According to Pakphan [3], the quality of academic services is the academic services experienced by students compared with those of student expectation. Students are the main stakeholders of higher education because they are interested parties and are directly influenced by learning and higher education management should be able to get what they want. The synergy of student expectations and campus interests will be achieved if academic services are carried out by prioritizing aspects of quality, adequate facilities, and professional management. Student satisfaction as users of educational services is very important for the progress of a university, students are a pillar of the sustainability of a university. This is because student satisfaction will have an impact on their loyalty to the university.

To measure service quality, it is necessary to understand the dimensions of service quality, one of the scales is SERVQUAL namely tangibles, reliability, responsiveness, assurance, and empathy [4] [5]. Satisfied students will provide benefits to the institution, for example, they will continue to use the services of the institution with further studies, they can also promote to others so that in the end it will improve the image of the institution. Semarang State University (UNNES) is one of Indonesia's universities located in the province of Central Java. The number of universities in Indonesia requires institutions to always be responsive to all changes that exist both internally and externally. To be able to improve achievement in terms of academics, service, and achievement, a special strategy is needed so that the institution can continue to survive. The prediction of student satisfaction is an important factor that determines the quality and sustainability of a university. UNNES is one of the institutions in higher education that use SERVQUAL to measure the satisfaction of service quality.

Measuring service quality in education institutions requires knowledge of patterns to predict the satisfaction of future users, a technique that can be used for that is data mining. Data mining can optimize the process of finding information in large databases and finding previously unknown patterns. In this study, the researcher wanted to apply the naive Bayes classifier method to predict student satisfaction with academic services. The Naive Bayes method has the advantages of being simple, fast, and very effective, works well with noisy and missing data, requires relatively few examples for training, but also works well with a very large number of examples, easy to get probability estimates for a prediction [20]. Based on the explanation that has been presented in the background, the problem that can be formulated is whether the Naive Bayes Classifier data mining algorithm for predicting student satisfaction with academic services produces a high enough level of accuracy. The adoptable instrument evaluation for improving academic service quality is a benefit of this research.

II. Literature Review

A. Related Research

Previous research using the Naive Bayes Algorithm was conducted by Syahputra et al., [6] with the implementation of data mining for predictions of students taking courses. The data used is based on the attributes of student data, namely Grades, IP, GPA, SKS, SKSK, and Semester, a classification process will be carried out to produce predictions of whether

the student is taking certain courses. The training data was taken from data in the odd semester in 2014 and the even semester in 2015. Furthermore, the testing data was taken from the even semester in 2016. The measurement of the accuracy value showed the results of 85.88% in the Customer Relationship Management course and 44.92% in the Wireless Network course.

The implementation of the Naïve Bayes theorem in universities is also carried out by Hasudungan & Pranoto [7] in predicting student achievement. Predictions of student academic achievement early on can determine the actions needed to improve student achievement who are predicted to have low achievement, so that in the future they can have good achievements. This study was conducted Naive Bayes Algorithm to measure student achievement and involves 16 parameters. This study has used 40 student data and the final results show that predictions using the Naive Bayes algorithm have obtained an accuracy value of 77.5%.

Meanwhile, to predict student graduation, the implementation of Naïve Bayes was carried out by Etriyanti et al., [8]. In this study, the Naive Bayes and the C4.5 Algorithm were used to predict the graduation of STMIK Bina Nusantara Jaya Lubuklinggau students. The results show that the C4.5 avaailable to predict the graduation status of students with an accuracy value reaching 79.08% while the Naive Bayes Algorithm is only 78.46%. In this test, the GPA-S4 variable became the dominant factor. And also the C4.5 algorithm has drawbacks, namely handling large data with the C4.5 method has several weaknesses, including: (1) empty branches, Nodes with values of zero or almost zero do not participate in rule creation or assist in building. class for classification tasks, but this increases the complexity and size of the tree; (2) not important Unimportant branches not only lessen the decision tree's usefulness but also cause (3) Overfitting is a problem when the algorithm model retrieves data in an unusual manner (noise) [19].

From the several studies that have been conducted above, the Naive Bayes Classifier has a good performance. Therefore, in this study, we try to implement the case of measuring service quality by academics to students at universities. Additionally, in previous research, no one discussed predicting student satisfaction with academic services.

B. Prediction

Prediction about the future based on current and past knowledge is called forecasting [9]. The ultimate goal of prediction is to make decisions based on considerations that may occur when the decision is implemented. However, prediction only tries to find an answer that is as close as possible to what will happen and does not have to give a definite answer. Basically, predictions are made based on the scientific method or are purely subjective. For example, the latest data and information based on observations (including satellites) can be used to predict the weather. This also applies to predictions on volcanic eruptions, earthquakes, and other related disasters. However, predictions can also be based on subjective views based on how everyone views them, for example, predictions on basketball matches, sports competitions, and so on.

C. Student Satisfaction

Satisfaction is obtained if human needs and desires have been met [10]. The achievement of desires and expectations is a manifestation of the scope of satisfaction. Furthermore, customer satisfaction is closely related to the existence of quality. In this study, student satisfaction as users of academic or educational services can also be measured. Several studies were conducted to find the relationship between student satisfaction with services in educational institutions. Several factors that correlate with student satisfaction are the way the teacher teaches a subject and the environmental conditions in which students study [11].

D. Academic Service Quality

Based on Parasuraman et al., (1988) in academic services there are 5 aspects which are dimensions of service quality [5], namely as follows:

1) Tangibles aspect, is an aspect that is physical in academics, such as; teaching tools, learning media, educational facilities, and infrastructure.
2) Reliability aspect, is an aspect with high ability and knowledge, non-discriminatory, and appropriate academic services provided by the university.
3) Responsiveness aspect, is an aspect related to responsiveness to help and provide fast and appropriate service to students.
4) Assurance aspect, is an aspect related to guarantee and certainty to foster students' confidence in educational institutions.
5) Empathy aspect, is an aspect to provides an understanding of the interests of students. In this case, the institution, lecturers, and academic staff give sincere and individual attention to students in trying to understand their wishes of students.

E. Data Mining

Today, the scale of the volume of data that is very large will only become garbage in storage memory if it is not processed into information. To process large amounts of data into information or knowledge discovery, a technique called data mining is needed. In general, there are 6 roles in data mining, namely description, prediction, estimation, classification, clustering, and association [12]. In its application, data mining is a part of the Knowledge Discovery in Database (KDD) process whose job is to extract patterns or models from data using a specific algorithm, the stages of data mining are as follows:

1) Data cleaning
2) Data integration
3) Data selection
4) Data transformation
5) Knowledge discovery
6) Knowledge presentation

The data types used in data mining are simply divided into 3, namely numeric data types, categorical data types, and time range data types. Numerical data types are divided into two parts, namely ratio, and interval. Categorical data types are also divided into two parts, namely ordinal and nominal.

F. *Naive Bayes Classifier*

The Naïve Bayes Classifier, a method of machine learning, uses probability and statistical methods for prediction based on independent data [13]. In its implementation, the Naive-Bayes Algorithm is often used in data grouping or data classification with large amounts. However, Naive-Bayes can also be used to predict conditions that will occur in the future or forecasting. The basis of Naïve Bayes used in programming is the Bayes formula:

$$P(A|B) = \frac{P(B|A)*P(A)}{P(B)} \quad (1)$$

The above equation means that the probability of event A as B is determined from the probability of B when A, the probability of A, and the probability of B [14]. In its later application, this formula changes to the following.

$$P(C_i|D) = \frac{(P(D|C_i)*P(C_i))}{P(D)} \quad (2)$$

III. METHODOLOGY

The research was conducted at the Informatics and Computer Engineering Education (PTIK) study program, Faculty of Engineering, the State University of Semarang located at Building E11, Faculty of Engineering, UNNES Campus, Gunungpati, Semarang City, 50229. The research was carried out from May 2022 to August 2022.

A. *Research Design*

The design of the research flow is illustrated in the illustration in Figure 1 below.

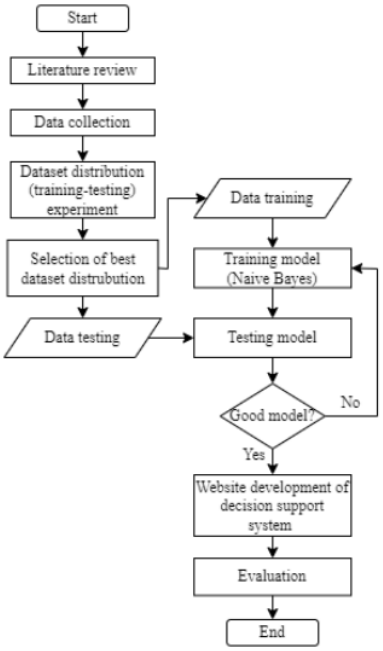

Fig. 1. Research design

The research started with data collection which was carried out with a survey of service aspects to students through Google forms starting from September 11, 2022, to September 19, 2022. The data obtained were recapitulated in a spreadsheet into a research dataset. The prediction system was developed with a website-based system product. The dataset is then distributed into training data and testing data by the split method. The dataset collected consisted of 85 students. The training data is then trained with the Naïve Bayes algorithm. The training is carried out through a website that has been designed by applying the Naive Bayes rule. The prediction model is then evaluated through accuracy testing based on the results of data testing. Then proceed to discuss the results to draw conclusions and recommendations for further research.

B. *Data Collection Techniques*

The population in this study were active students of the PTIK study program of UNNES from class 2017 to class 2020. The sample is an alternative that can be used by researchers because the amount of population data is too much. This study uses a systematic random sampling technique based on the survey construct by SERVQUAL.

TABLE 1. DIMENSIONS OF SERVQUAL

Constructs	Dimensions
Tangibles	The neat appearance of the staff
	Satisfactory library facilities and office
	Comfortable classrooms
Reliability	Lecturers and staff provide high ability and knowledge
	Lecturers and staff are not discriminatory
	The university provides decent academic services
Responsiveness	Lecturers and staff are fast response
	Proper academic services
	Handling complaints quickly
Assurance	Service standard with high quality
	Excellent quality of administrative services
	Excellent quality of academic services
Empathy	Lecturers and staff serve students in a friendly manner
	Provide easy-to-understand information

The datasets used in this experimental study are primary data obtained directly from research respondents, namely students at PTIK UNNES. Collecting data using primary data obtained from students using a questionnaire. Questionnaires were distributed to students of the PTIK UNNES. The measuring instrument uses a Likert scale with 4 categories of answers which are shown in the following table 2:

TABLE 2. ALTERNATIVE SCORES OF SERVICE SATISFACTION QUESTIONNAIRE ANSWERS

Category	Answer's Score
Not Satisfied (NS)	1
Quite Satisfied (QS)	2
Satisfied (S)	3
Very Satisfied (VS)	4

C. *Data Analysis Technique*

The data analysis technique used is accuracy. Accuracy is a test method based on a comparison between the predicted value and the actual value. By knowing the amount of data that is classified correctly and then compared with the total

predicted data, the accuracy of the prediction results can be known. The accuracy equation is described as follows:

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \; x\,100\% \qquad (3)$$

In the above equation, it means TP is a true positive value, and TN is a true negative value. While FP is a false positive value and FN is a false negative value. Accuracy describes the probability of a correct prediction made by the system. This data analysis only uses accuracy because this research is in line with previous research, accuracy has shown the performance of the method.

IV. Results And Discussion

Data from the survey are 5 aspects of service satisfaction consisting of tangibles, reliability, responsiveness, assurance, and empathy. These 5 aspects are used in this study because these parameters are the reference and are used at the State University of Semarang. Each aspect can be filled with the 4 classes shown in table 3 to determine the probability of each aspect. The percentage range of probability values is used to determine which data belongs to which class. This probability becomes the classification rule in predictions

TABLE 3. PROBABILITY OF CLASSIFICATION RULE

Answers	Probability Rules
Very Satisfied (VS)	76%-100%
Satisfied (S)	51%-75%
Quite Satisfied (QS)	26%-50%
Not Satisfied (NS)	0%-25%

The sampling technique used is the split test, which uses the distribution of training and testing: 60%-40%, 70%-30%, 75%-25%, and 80%-20%. In this study do not consider imbalanced class. This distribution experiment gives the best dataset distribution to the system that will be implemented. A total of 85 data were tested with 4 differences in the distribution of the percentage of training and testing to get the best classification rules sample of the training dataset used in this research is shown in table 4.

TABLE 4. SAMPLE OF DATA TRAINING

No	Tangibles	Reliability	Responsiveness	Assurance	Empathy	Label
1	VS	S	S	VS	VS	VS
2	VS	VS	VS	VS	VS	VS
3	VS	VS	VS	S	VS	VS
4	VS	VS	QS	QS	QS	S
5	VS	VS	S	S	S	S
..	..	..	..	..	..	..
50	VS	VS	VS	VS	VS	VS

The test results use the accuracy value to assess the performance of the prediction model made. The accuracy value indicates the probability of the ability to predict the test data correctly. The sample of results in testing data used is shown in Table 5.

TABLE 5. SAMPLE OF RESULT IN TESTING DATA

No	A1	A2	A3	A4	A5	Prediction
1	S	S	S	S	S	S
2	VS	VS	VS	VS	VS	VS
3	QS	QS	QS	QS	S	VS
4	S	S	S	S	S	S
5	VS	VS	S	VS	S	VS
..	..	..	..	..	..	..
35	VS	VS	VS	VS	S	VS

Training data using the Naive Bayes Classifier algorithm. The selection of the Naive Bayes algorithm is based on several experiments on relevant cases resulting in good prediction accuracy in using Naive Bayes. In addition, the use of Naive Bayes also requires a relatively short processing time so it is very efficient [15] [16] [17] [18]. This information was obtained from related studies including those conducted by Pallathadka et al., (2021), Kusumawati et al., (2019), Makhtar et al., (2017), and Doreswamy & Hemanth (2011). In this study also produced the same results, which showed that the performance by Naive Bayes was very fast and efficient in predicting academic service satisfaction.

From the testing process that has been carried out in this study. The lowest model accuracy is distribution 1 with 91% and the highest accuracy is distribution 3 with 95%. The calculation of the accuracy in the 4 distribution experiments is as follows.

TABLE 6. DISTRIBUTION EXPERIMENT RESULT

	Datasets Distribution		Accuracy
	Training	Testing	
Distribution 1	60%	40%	91%
Distribution 2	70%	30%	92%
Distribution 3	75%	25%	95%
Distribution 4	80%	20%	94%

These results indicate that there is a difference in the accuracy of the system based on the experiment of distribution of the amount of training and testing data. The difference is not too significant with a maximum difference of 4%. Based on the experiments that have been carried out, all the results show good performance with accuracy above 90%, but the composition of 75% for training and 25% for testing is the best composition result with an accuracy of 95%. To illustrate these results, the following bar graph was created.

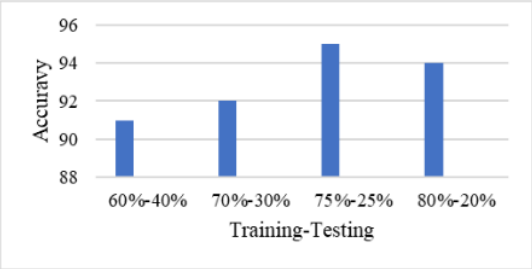

Fig. 2. Model accuracy of different distributions of datasets

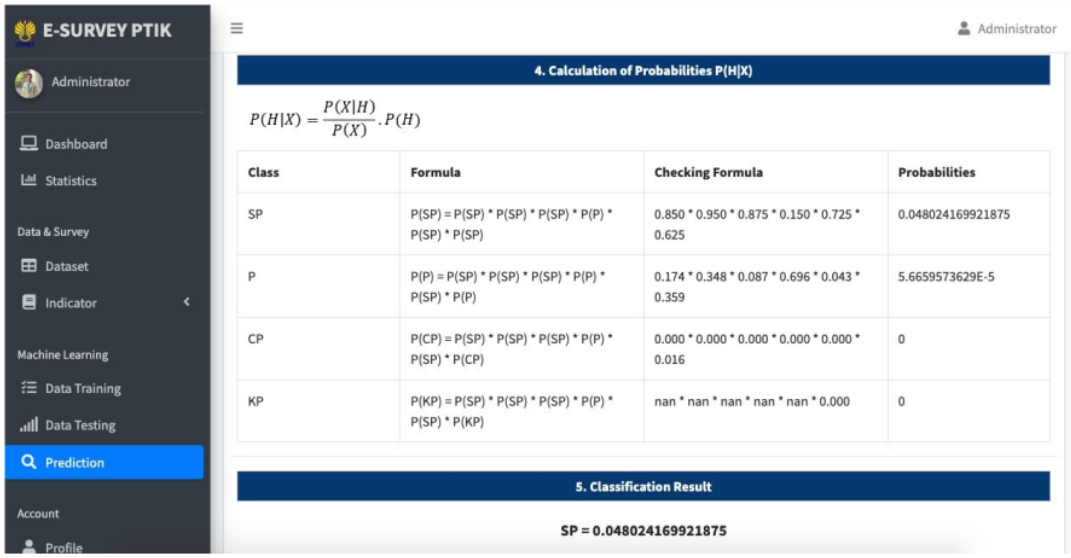

Fig. 3. Prediction feature on the website

The model is developed with the website in the decision support system related to student satisfaction in academic services. Based on these results, it is concluded that the prediction model in the form of a website that is made can predict student academic service satisfaction with very good performance. The output of the prediction website for student academic service satisfaction has a predictive feature where test data need to fill in 5 aspects of satisfaction shown in Figure 3. The system will automatically assess the probability of total satisfaction from students and categorize the probability values into classes as shown in the list in table 2 based on the built Naive Bayes rule.

Based on the research findings, the prediction rule implementation by implementing the Naive Bayes algorithm on the website has good performance. Value and order in each aspect into consideration and affect the prediction results. The rules that are formed are representative so that the testing results are included in the good category. The more the amount of training and testing data, the better the system will be.

The evaluation obtained is weaknesses in wrong predictions occur because Naive Bayes has rules that are independent in each class. So if the test data is not in the training data set, the model will assign a probability of zero and will not be able to make predictions. So it is recommended to need a large set of datasets to make a reliable estimate of the probability of each class. We can use the Naive Bayes classification algorithm with small amounts of datasets, but the accuracy obtained may be low if the number of training for each class is not large or not representative.

V. Conclusions And Suggestions

Research on predicting student satisfaction with academic services at the PTIK Study Program of the State University of Semarang using the Naïve Bayes algorithm method produces a model and website that predicts student academic service satisfaction with the best accuracy of 95% by the distribution of 75% data for training and 25% for testing. It is concluded to be a very good classification model. A suggestion for further research is to add the number of datasets used and choosing the best data distribution in training and testing because it has been proven to affect system performance. With the bigger dataset for training models, they are represented in each class so that the possibility of wrong predictions in the model can be minimized.

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