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New Student Admission Forecasting Model with Support Vector Machine Method: Case Study of Bali State Polytechnic

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ABSTRACT

Every educational institution, both formal and non-formal, organizes new student admissions every year. This process requires institutions to improve the quality of education, services, and accreditation, both in terms of student competence, facilities, and infrastructure. Therefore, effective and efficient planning is needed, especially in making strategic decisions. This research aims to forecast the number of new student admissions using the Support Vector Machine (SVM) method. SVM is one of the artificial intelligence techniques known to have a high level of accuracy in data analysis and forecasting. The results showed that the SVM method was able to produce predictions with a low error rate. The test results using Root Mean Square Error (RMSE) show that the Electrical Engineering study program has the best RMSE value of 7.292, making it the study program with the highest level of forecasting accuracy in this study. This finding proves that the SVM method can be effectively implemented in forecasting new student admissions, so that it can help institutions in developing better and data-based admission strategies.

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1. INTRODUCTION

Every educational institution, both formal and non-formal, annually organizes new student admissions as part of a continuous academic process. Universities strive to continuously improve the quality of education, service quality, and accreditation through various aspects, including increasing student competence, providing adequate facilities and

infrastructure, and optimizing the new student selection process [1]. Therefore, planning is needed that is not only effective, but also efficient, especially in making strategic decisions that have an impact on the sustainability of the institution.

One of the challenges in the admission process is the uncertainty of the number of prospective students who apply and are accepted each year. This fluctuation can be influenced by various factors, such as the attractiveness of study programs, educational policies, labor market trends, and economic and social factors. To overcome this challenge, a data-driven approach is needed that can assist institutions in making more accurate predictions of the number of new student admissions. The Support Vector Machine (SVM) method is one of the artificial intelligence techniques that has been widely used in the field of forecasting, including in predicting the number of student admissions [2]. SVM has the advantage of handling nonlinear data, optimizing relationship patterns in data, and producing predictions with a high level of accuracy. Several previous studies have proven the effectiveness of this method in various forecasting fields, such as electricity load prediction, inflation forecasting, and blood demand estimation.

From Isnaeni's research, predicting the inflation rate with the SVM method which has a part, namely SVR using the RBF kernel, obtained an RMSE value of 0.0020. Shows the error results of the SVM method with a minimal error rate [3]. According to Pratama's research focuses on forecasting blood demand using the SVM method. By trying several tests starting from MAPE and MSE. Produces the best MAPE value, namely in blood type B blood with a percentage error of 13% [4]. Research conducted by Rifqi uses the SVR method which is part of the SVM method for forecasting blood demand. Focusing on PMI has a blood storage problem. Produces a predictive value using testing with MAPE resulting in an error of less than 10% [5]. In research conducted by Taringan on the comparison of SVM and backpropagation models in forecasting the number of foreign tourists. Using the radial kernel model for the SVM method. Tried several tests such as MSE with a result of 0.0009, secondly using the MAE result of 0.0186, and finally using MAPE with a result of 0.0276 [6].

In this research, the SVM method is applied to forecast the number of new student admissions at Politeknik Negeri Bali based on available historical data. By applying the SVM method, this research aims to produce a prediction model that can assist institutions in managing student admissions in a more structured and data-driven manner. In addition, this research also evaluates the accuracy of the model using Root Mean Square Error (RMSE) as the main parameter in assessing forecasting performance.

2. RESEARCH METHOD

Support vector machines (SVM) is a machine learning technique based on the principle of minimum risk statistical theory structure in the simplest sense. This method can be used in various fields such as classification (clustering), regression, character recognition and time series [7]. It was proposed by Vapnik in 1992 for classification problems [8]. Later

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in 1995 it became its updated version used today by Cortes and Vapnik [9]. It was later developed by Vapnik et al in 1997 and adapted to regression problems.

Unlike other machine learning methods, SVM focuses on minimizing structural risk. Therefore, it does not require a lot of data, like other machine learning methods, does not rely on local op timum solutions, does not overfit and underfit. The working principle of SVM in regression method is to find a linear separating function that conforms to statistical learning theory, i.e. the closest approximation of the training data to reality. In nonlinear data sets, kernel functions are used [10]. Support vector machines are a combined version of statistics and artificial neural network techniques. It is essentially a two-layer feedforward neural network due to the sigmoid kernel function used. It divides the data optimally into two [10].

When support vector machines were introduced, they were made for linear problems. However, with the advantage of the working principle of the method, it can be adapted to nonlinear problems by changing the kernel function as it takes into account the calculation of the inner product of the training data in the training of the machine or vector. In simple definition, it converts the nonlinear input set into linear inputs with the help of kernel function and then solves the problem like a linear problem. Therefore, they give excellent results in nonlinear regression problems [10].

The calculation of SVM regression is given in the equation below [11]. A simple calculation for training an SVM regression model is given as in Equation 1, where xi denotes input, yi denotes output, Rn denotes the n-dimensional input space and R is the output space.

$$\{x_i, y_i | x \in R^n, y \in R, i = 1,2, \dots, m\} \quad (1)$$

The prediction model for the SVM method is as in Equation 2.

$$f(x) = w^t \varphi(x) + b \quad (2)$$

Where w is the weight vector; b is the deviation vector, φ(x) is the nonlinear mapping function.

In this research, the Support Vector Machine (SVM) method is used to forecast the number of new student admissions at Politeknik Negeri Bali. This method was chosen because of its ability to handle nonlinear data and provide prediction results with a high level of accuracy. The research steps taken include data collection, data normalization, application of the SVM method, and evaluation of model accuracy using Root Mean Square Error (RMSE).

The data used in this study are historical data of new student admissions from 2017 to 2020 for five study programs, namely Electrical Engineering, Informatics Management, Managerial Accounting, International Business Management, and Tourism Business Management. This data was obtained from the Computer Center (PUSKOM) of Politeknik Negeri Bali. The main variables in this study consist of the number of applicants and the number of students accepted each year.

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2.1 Data Normalization

Before the data is used in the SVM model, a normalization process is carried out to scale the data values into the range [0,1]. Normalization aims to improve model stability and accelerate the convergence process in the SVM algorithm. The normalization technique used in this study is the Min-Max Scaling method

2.1.1 Min – Max

Normalization is the process of scaling the attribute values of the data so that they fall within a certain range [12]. There is also a min-max method with transformation to the interval [0,1].The Min-Max method is a normalization method by performing a linear transformation of the original data There is also a min-max method with transformation to the interval [0,1] [6].

$$X' = \frac{0.8(X - b)}{(a - b)} + 0.1 \quad (3)$$

Where:
X' = normalized data
X = original data
a = maximum value of original data
b = maximum value of original data

2.2 Root Mean Square Error (RMSE)

The Support Vector Machine (SVM) method is used in this research to forecast the number of new student admissions. SVM works by finding the optimal hyperplane that separates data based on existing patterns, and can be applied in regression using Support Vector Regression (SVR). In this research, the Radial Basis Function (RBF) kernel is used because it has the ability to handle data with complex nonlinear patterns. The SVM model is implemented with the following steps:

1) Determining model parameters such as C value (regularization parameter) and gamma (RBF kernel parameter).
2) Train the SVM model using normalized data.
3) Predict the number of new students based on available historical data.

In multiple linear regression can be calculated using the Least Squares Method (MKT), one of which is the Root Mean Square Error (RMSE). RMSE is a measure that is often used to find the difference between predicted values in the model. RMSE is a measure of the amount of error in prediction and serves to calculate [13].

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Model accuracy is evaluated using Root Mean Square Error (RMSE), which is one of the common metrics in measuring the level of prediction error in regression models. The RMSE formula is as follows:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(Yi-\hat{Y}i)^2}{n}} \quad (5)$$

Description:
Yi = true data (initial data)
Ŷi = estimated data (final data)
n = number of data

The accuracy of the estimation measurement is indicated by the RMSE result with a small value (close to zero). A smaller RMSE value is said to be more accurate than a larger RMSE. Where a good standard error is the range between 0.0 - 1.0, if more than 1.0 is classified as large [13].

3. RESULTS AND DISCUSSION

This section discusses the research results obtained from the application of the Support Vector Machine (SVM) method in forecasting new student admissions at Politeknik Negeri Bali. The process includes data collection, normalization, model training, and accuracy evaluation using Root Mean Square Error (RMSE).

The process of forecasting a new student admission system will be explained in more detail in the discussion section. Starting from collecting New Student Admission Data. Second Normalization process to process data into a value range of 0 to 1. Third SVM method used to perform forecasting. Fourth, the RMSE process as a measure of the accuracy of forecasting. Finally, RMSE results to compare the accuracy of the forecasting that has been done. Then for more detailed steps, as follows:

3.1 Collecting New Student Admission Data

The data used in this study were obtained from the Bali State Polytechnic Computer Center (PUSKOM), which includes the number of applicants and the number of students accepted in five study programs from 2017 to 2020. The following is data on new student admissions from 2017-2020

Collecting new student admission data is done by requesting new student data to the PUSKOM section. The data used is data for electrical engineering, infotmatika management, managerial accounting, international business management, and tourism business management study programs from 2017 to 2020. For example the data used is in the form of years, registrants, and accepted for each study program. Here is one example of data from the informatics management study program from 2017 to 2020.

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Table 1. New Student Admissions for Informatics Management Study Program from 2017-2020

Year	Applicants	Accepted
2017	235	137
2018	218	115
2019	258	130
2020	228	150

Table 2. New Student Admissions for the Electrical Engineering Study Program from 2017-2020

Year	Applicants	Accepted
2017	246	137
2018	266	120
2019	205	140
2020	193	158

Table 3. New Student Admissions for Managerial Accounting Study Program from 2017-2020

Year	Applicants	Accepted
2017	1067	229
2018	1069	220
2019	1017	209
2020	319	68

Table 4. New Student Admissions for International Business Management Study Program from 2017-2020

Year	Applicants	Accepted
2017	654	196
2018	708	179
2019	659	177
2020	674	213

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Table 5. New Student Admissions for Tourism Business Management Study Program from 2017-2020

Year	Applicants	Accepted
2017	868	166
2018	738	200
2019	821	198
2020	807	193

From the data, it can be seen that the number of students admitted fluctuates every year. Similar trends also occur in other study programs

From Table 1 to Table 5 above, it can be seen that the number of new students admitted almost every year is increasing. The data used for forecasting is accepted. Accepted data will be calculated with each year's enrollment. Data from other study programs are also the same from 2017 to 2020 with the same thing. The acceptance data will then be processed to the normalization stage.

3.2 Normalization

The normalization process is a process to make the data distance to 0 to 1. Normalized data is new student admission data from 2017 to 2020 will be normalized. After that the data is entered into the SVM method for forecasting, and finally it will be tested with RMSE checking the error value of each study program [14];[18];[19].

Before being used in the SVM model, the data that has been collected is normalized using the Min-Max Scaling method to ensure the scale of the data is in the range [0,1]. This process aims to improve the stability and accuracy of the model [15];[20].

3.3. SVM Method Implementation

The SVM method is a method that is often used in various fields, one of which is forecasting. In this study, the SVM method was used to perform forecasting of new student admission data. With the procedure of the SVM method can be seen in section 2 method. After the new student admission data is normalized. The data can be seen to have two attributes, namely "number of applicants" and "number accepted" for each year. For data input, using the number of applicants data, and for the target, using the number of accepted data. Next, determine the average value for the "number of applicants" and "number accepted" data. After that, calculate the standard deviation for the "number of applicants" and "number accepted" data. Finally, calculate the SVM value for each data point. The results of the SVM method are then calculated to the RMSE process.

After the data is normalized, the SVM model is applied to forecast the number of students accepted in each study program. The model is trained using data from 2017 to 2019,

while 2020 data is used for testing to evaluate model performance. Here are some predicted results for each study program:

Table 6. Prediction of new student admissions Informatics Management Study Program from 2017-2020

Year	Accepted	Prediction
2017	137	133
2018	115	134
2019	130	132
2020	150	133

Table 7. Prediction of new student admissions Electrical Engineering Study Program from 2017-2020

Year	Accepted	Prediction
2017	134	130
2018	117	130
2019	134	130
2020	136	132

Table 8. Prediction of new student admissions Managerial Accounting Study Program from 2017-2020

Year	Accepted	Prediction
2017	229	185
2018	220	183
2019	209	181
2020	68	177

Table 9. Prediction of new student admissions International Business Management Study Program from 2017-2020

Year	Accepted	Prediction
2017	196	192
2018	179	190
2019	177	192
2020	213	191

Table 10. Prediction of new student admissions Tourism Business Management Study Program from 2017-2020

Year	Accepted	Prediction
2017	166	188
2018	200	191
2019	198	189

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2020	193	189

It can be seen from tables 6 to 10 the prediction results of each study program from 2017 to 2020. From this table, error calculations will then be carried out using the RMSE model.

3.4 Model Evaluation Using RMSE

The RMSE process is used as a measure of the accuracy of forecasting. By calculating the results of the SVM method minus the original data, and divided by the amount of data. Can be seen in method section 2 for more explanation [13];[16];[17].

The performance of the SVM model is evaluated using Root Mean Square Error (RMSE), where the smaller the RMSE value, the higher the accuracy of the model in making predictions.

3.5 Result

The RMSE result is the error value of the RMSE process. In this study conducted by comparing 5 other study programs with the SVM method. The following are the results of the RMSE results of the 5 study programs. In table 11

Table 11. RMSE Testing Results from 5 Study Programs

Study Programs	RMSE
ELECTRICAL ENGINEERING	**7.29**
INFORMATICS MANAGEMENT	12.70
MANAGERIAL ACCOUNTING	63.16
INTERNATIONAL BUSINESS MANAGEMENT	14.37
TOURISM BUSINESS MANAGEMENT	12.68

Can be seen in table 11. Results of RMSE from 5 study programs. Starting from the RMSE value of the electrical engineering study program with a value of 7.29, the informatics management study program with a value of 12.70, the managerial accounting study program with a value of 63.16, the international business management study program with a value of 14.37, and the tourism business management study program with a value of 12.68. From the RMSE results, it can be seen that the smallest value is in the electrical engineering study program with an RMSE value of 7.292. Then the electrical engineering study program is the best study program in forecasting.

Based on the above results, the Electrical Engineering study program has the lowest RMSE value, which is 7.29, which indicates that the SVM model has the best level of

accuracy in forecasting the number of new students for this study program. In contrast, the Managerial Accounting study program has the highest RMSE value, which is 63.16, indicating a greater level of prediction error than other study programs.

3.6 Data analysis

New Student Admissions from 2017-2020 were analyzed by the average value of RMSE. Can be seen in figure 1.

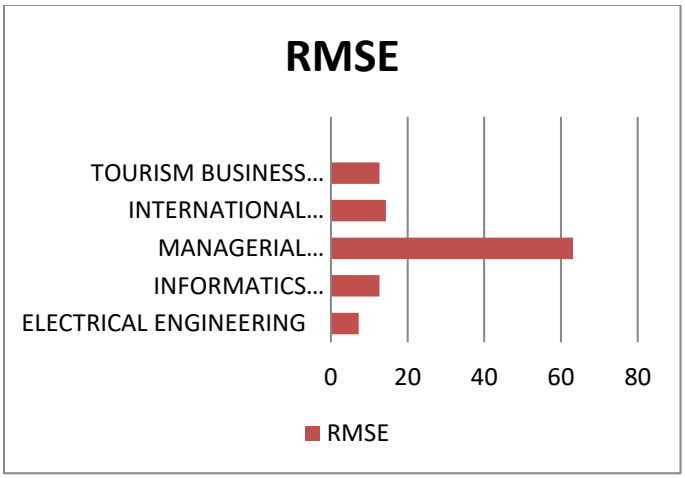


Figure 1. Average RMSE

The results of RMSE from 5 study programs can be seen in Figure 1. The smallest RMSE result is in the electrical engineering study program with an RMSE value of 7,292. Then the electrical engineering study program is the best study program in forecasting.

From the results obtained, there are several important findings:

1) Electrical Engineering Study Program has the best prediction, with the lowest RMSE (7.29), indicating that the pattern of student admissions in this study program is more stable and can be predicted well by the SVM method.
2) Managerial Accounting Study Program has a prediction with the highest error rate (RMSE 63.16), which is likely due to fluctuations in the number of applicants and accepted students each year, making it difficult for the model to find a consistent pattern.
3) Overall, the SVM method proved effective in forecasting new student admissions, especially in study programs with more stable data patterns.

The results of this study indicate that the Support Vector Machine (SVM) method can be used as a tool in planning new student admissions, especially in identifying trends in the number of students admitted to various study programs. This model can assist

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institutions in developing a more data-driven admission strategy and improve the efficiency of resource management.

4. CONCLUSION

Based on the results of the research conducted, it can be concluded that the Support Vector Machine (SVM) method is effectively used in forecasting new student admissions at Politeknik Negeri Bali. The model developed shows that SVM is able to produce predictions with a relatively low error rate, especially in study programs with more stable data patterns. The main conclusions of this research are as follows:

1. The application of the SVM method in forecasting new student admissions was successful. This model is able to process historical data and produce predictions of the number of students accepted with a fairly high level of accuracy.
2. Model evaluation using RMSE shows that the Electrical Engineering study program has the best prediction, with an RMSE value of 7.29. This result shows that the pattern of student admissions in the study program is more stable than the other study programs.
3. Managerial Accounting study program has the highest RMSE value, 63.16, which indicates a greater level of prediction error. This indicates that there are significant fluctuations in the number of applicants and accepted students each year, making it more difficult for the model to find a consistent pattern.
4. The SVM method can be a useful tool for educational institutions in planning new student admissions. With more accurate predictions, institutions can develop more efficient admission strategies and optimize the management of available resources.

To improve future forecasting results, some suggestions that can be considered are: First Using a combination of other forecasting methods such as Long Short-Term Memory (LSTM) or Random Forest Regression to compare with SVM to obtain a more optimal model. Second Expanding the coverage of historical data by adding data from previous years so that the model has more information in finding patterns of student enrollment trends. Lastly Exploring various kernel parameters in SVM to improve model accuracy, especially in study programs with high fluctuations in the number of applicants and accepted students. With this research, it is hoped that artificial intelligence-based methods such as SVM can be increasingly applied in the world of education to help make decisions that are more data-based and objective.

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