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APPLICATION OF SUPPORT VECTOR MACHINE ALGORITHM FOR STUDENTS' FINAL ASSIGNMENT STRESS CLASSIFICATION

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Abstract

In the context of higher education, the final assignment represents the last step in a student's academic journey, a period where students are particularly susceptible to stress. Implementing machine learning techniques, such as the Support Vector Machine (SVM) method, presents a promising approach for early classification of students' stress levels and offers tailored stress management recommendations. This study adopts a quantitative research approach, aimed at classifying student stress levels using the SVM algorithm known for its high prediction accuracy. The research methodology encompasses stages like data collection, preprocessing, classification, results analysis, and accuracy evaluation. In this research, 80% of the dataset is allocated for training, while the remaining 20% is reserved for testing. The study finds that the most effective SVM kernel function is the Radial Basis Function (RBF) with a γ parameter value of 1, which, when applied using RapidMiner, achieves an accuracy of 93.33%. This research is anticipated to make a significant contribution to the development of early stress detection systems for students and offer valuable insights into leveraging machine learning technology for mental health applications. The findings demonstrate that the SVM method with the RBF kernel provides highly accurate classification results, making it a useful tool for effectively identifying student stress levels.

***Keywords**: Student Stress, Classification, SVM, RapidMiner*

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1. INTRODUCTION

The final assignment for students is an obligation that must be completed by college students. For example, undergraduate college students (S1) are required to complete a final assignment in the form of a thesis. However, working on a thesis is not as easy as working on papers or assignments for courses in general.[1][2]

Many things can be obstacles to being able to complete a thesis. The more complex the activities related to the process of working on the final assignment, the higher the level of difficulty felt by students. This phenomenon can have implications for the emergence of various student reactions to the final assignment such as anxiety, difficulty concentrating, and delaying working on the thesis, making students feel burdened and stressed.[3]

Stress is a condition that is often encountered by students, especially final year students. Students who are compiling their final assignments are individuals who are prone to stress. Students who experience stress tend to experience disorders in physical, emotional, cognitive, and behavioral functions that can have an impact on completion time.[4] [5][6]

In facing these challenges, it is important for educational institutions to understand and support students in dealing with stress during the final assignment writing process. The application of machine learning technology and methods, such as the Support Vector Machine method, can be a potential solution in helping to classify students' stress levels early and provide appropriate stress management recommendations.[7]

SVM has been successfully applied in various fields, including text classification, facial recognition, and emotion analysis. In the context of research on the classification of students' stress levels towards final assignments, SVM can be used as a tool to build a classification model that can identify whether a student is experiencing low, medium, or high levels of stress based on the data collected.[8][9][10]

The application of SVM to classify students' stress levels in final assignments has several advantages.

SVM can overcome classification problems on complex and high-dimensional data, which are often encountered in mental health analysis. In addition, SVM also has good tolerance to overfitting, thereby reducing the risk of inaccurate and poorly generalizable models.[11], [12]

There is some research that has been done using the Support Vector Machine model to solve problems in various fields. In the study entitled "Implementation of Vector Support Machine for Stress Detection in E-Learning Users". The study conducted accuracy testing with 12 sample data obtained from 4 respondents selected from students who have used e-learning. The characteristic used for stress classification is by using features from the Heart Rate Statistical domain, namely Mean Heart Rates, Median Heart rates, Mean Absolute Deviation Heart Rats and Standard Deviations Heart Ratas. The accuracy of the comparison between the classification results and the real condition of the respondents can reach 58.3%.[13]

In addition, the study entitled, "Support Vector Machine (SVM) and Comparison of Decision Tree Algorithms for Student Depression Detection," is being discussed. When compared to the decision tree approach, the SVM method is more accurate since its accuracy is roughly 0.02% higher than that of the decision tree that results from it. Therefore, it may be concluded that SVM are more effective at identifying pupils' depression levels.[14]

Additional research entitled "Application of Vector Machine Support Method (SVM) to Detect Drug Abuse". The study concludes that the best accuracy rate result was achieved on the 70/30 scheme, or 83.3%, when the SVM Linear model was used for classification on three different data splitting schemes.[15]

The results of this study can be used to give recommendations to students who experience high levels of stress related to their final tasks. In addition, the research also helps in designing appropriate support to cope with student stress. Moreover, the study has the potential to make a positive contribution to the education system by helping colleges in identifying and managing student stress more effectively, thereby improving their academic well-being.

Thus, the study aims to apply the SVM method to students' understanding and stress management of final tasks, with the hope of providing convenience to graduate students who want to know the stress levels when drawing up a thesis.

2. RESEARCH METHOD

A research framework is a structure or plan used by a researcher to design, develop, and conduct research. It helps researchers to ensure that their research is well organized and directed.

This research framework will help in planning, conducting, and evaluating research more systematically. It is also a useful tool for communicating with others about the objectives, methods, and results of the research. As a comprehensive guide, Figure 1 shows the steps that must be taken in order to do the research.

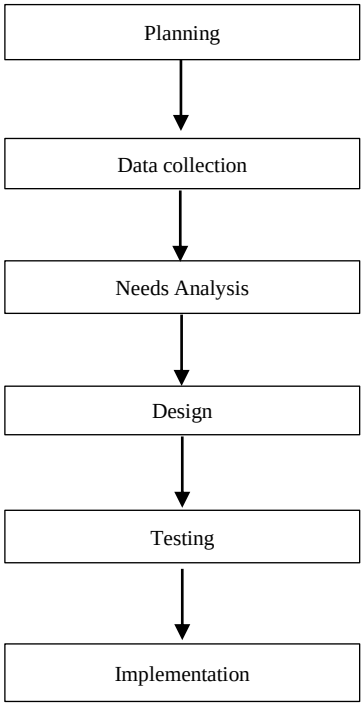

Figure 1 Framework of Research

2.1 Planning

This study uses a quantitative approach with the main objective of classifying students' stress levels using the Support Vector Machine (SVM) algorithm. The research methodology includes the stages of data collection through questionnaires, data preprocessing, classification using SVM, and accuracy testing. The data obtained will be processed for classification, and the results will be assessed based on the distance of the test data to the nearest training data. The accuracy of the classification results is then tested by comparing the system results with the real conditions of the user.

2.2 Data collection

In this study, the data collection techniques used include two main methods:

1. Literature Study: Collecting and reviewing books, magazines, and other literature relevant to the problem and objectives of the study. This study is used to compare and improve the shortcomings of previous studies.
2. Observation: Conducting direct observations through questionnaires distributed to students. This questionnaire contains questions related to the final assignment, which aims to collect data on students' stress levels.

2.3 Needs Analysis

In this study, data collection was conducted at the State Islamic University of North Sumatra. The questionnaire was distributed to final year students at UINSU Tuntungan.

In this case, there are several research variables that affect students' stress levels, namely:
1. Personal
Student personality such as the habit of delaying working on thesis and getting angry easily.
2. Family
Pressure from parents to quickly complete the final assignment or thesis.
3. Lecturer
Difficulty meeting for guidance with the supervisor and continuous revisions.
4. Environment
Unstable environment such as frequent riots.

2.4 Design

The design of a Support Vector Machine (SVM) model involves several important steps to build an effective model. First, the dataset is divided into two subsets: training data to train the model and testing data to evaluate its performance. Data preprocessing processes, such as normalization or feature standardization, are performed to ensure model consistency. The SVM model is then trained with the training data to find the best hyperplane that separates the data classes, using support vectors. The validity of the model is tested using cross-validation techniques to ensure model generalization. After training and validation, the model is tested on a separate testing dataset to measure performance using metrics such as accuracy, precision, recall, and F1-score. This step ensures that the SVM model can classify data accurately and effectively.

2.5 Testing

Testing the SVM model is essential to evaluate its performance in classifying data with high accuracy. The testing steps include splitting the dataset into training and testing data, training the model on the training data, and then testing it on unseen data to measure accuracy, precision, recall, and F1-score. Analysis of the confusion matrix is also performed to assess the model's ability to identify different classes. The results of these tests are important to ensure the reliability and generalization of the SVM model to new data.

2.6 Implementation

The application used in this study is RapidMiner which aims to help classify the level of student stress towards the final assignment based on the factors that cause stress in working on the final assignment. The output provides the results of the classification of the level of student stress towards the final assignment, then the results are evaluated to ensure a high level of accuracy. The researcher will ensure that the results obtained have an optimal level of accuracy. The results of this study are expected to provide a positive contribution to the campus related to providing accurate and useful information.

3. RESULT AND DISCUSSION

3.1 Data analysis

This study uses the Support Vector Machine (SVM) algorithm to predict students' stress levels based on datasets obtained from questionnaires. This questionnaire was distributed to final year students of the Computer Science study program at the State Islamic University of North Sumatra and contained 8 questions related to the psychological side of students that affect stress levels. From this questionnaire, 4 features or input variables were identified that represented "mild", "moderate", and "high" stress levels. The collected questionnaire results are listed in Table 1, which contains 151 respondents who have responded.

Tabel 1. Questionnaire Result Data

No	Initials	X1		X2		X3		X4	
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1	SR	3	3	2	2	2	2	2	2
2	FAY	2	3	3	2	1	1	1	1
3	DA	4	3	2	1	3	2	4	4
4	MK	2	2	3	4	4	4	4	3
5	NZ	4	4	3	3	3	3	2	3
				.....					
				.....					
				.....					
151	AH	3	2	2	2	1	1	3	3

Research and testing in this study is by finding the highest level of accuracy in the Support Vector Machine algorithm. In this study, 80% of the dataset will be used as training data and 20% will be used as test data. To see whether the search for the highest level of accuracy is good or not, a performance analysis will be carried out based on the accuracy results of each dataset used. Where to measure the level of accuracy can use the following equation (1).

$$Accuracy = \frac{TP + TN}{P + N} \times 100\%$$

$$= \frac{number\ of\ correct\ predictions}{All\ data\ is\ predicted} \times 100\% \ldots (1)$$

3.2 Data Processing Process

The data processing process is to group data in the form of numbers into Low, Medium, High level descriptions. Data in the form of numbers are added up and the maximum and minimum scores are sought. The classification results are in the table 2.

Tabel 2. Data Selection Results

No	X1	X2	X3	X4	Total	Y
Mhs1	6	4	4	4	18	Moderate Stress
Mhs2	5	5	2	2	14	Moderate Stress
Mhs3	7	3	5	8	23	Moderate Stress

Mhs4	4	7	8	7	26	High Stress
Mhs5	8	6	6	5	25	High Stress
			.....			
			.....			
			.....			
Mhs151	5	4	2	6	17	Moderate Stress

Mhs151 5 4 2 6 17 Moderate Stress
Minimum score = lowest score scale * number of variables (x) = 2 * 4 = 8
Maximum score = highest score scale * number of variables (x) = 8 * 4 = 32
Mean = (max score + min score) / 2 = (32 + 8) / 2 = 20
So that the category of student stress level data is as follows:

Stress Category:
Mild $x < 16$
Moderate $16 \leq x < 24$
High $x \geq 24$

Where the value of x is the number of scores obtained. So in the calculation of the case of stress level classification in this student, the results are obtained as in Table 2.

3.3 SVM Training Process

In the SVM training process, 9 data will be taken randomly from the 151 data displayed. The data can be found in table 3.

Tabel 3. Student Data Used

Student Name	X_1	X_2	X_3	X_4	Y
Mhs 9	6	7	4	5	Moderate Stress
Mhs 11	6	4	2	2	Mild stress
Mhs 12	7	4	4	8	Moderate Stress
Mhs 14	6	6	6	7	High Stress
Mhs 20	5	5	4	5	Moderate Stress
Mhs 21	4	5	4	3	Mild stress
Mhs 22	6	5	8	8	High Stress
Mhs 59	6	7	7	5	High Stress
Mhs 60	4	3	3	6	Mild stress

Description:

X1: Personal
X2: Family
X3: Lecturer
X4: Environment
Y: Stress Level

3.4 Training Data Input

1. Level 1 Training Data

In the calculation of SVM level 1, the data to be executed is the data in class 1, namely the mild stress level. The executed data is given a value in the system class = 1 (positive class) and data other than the mild stress class will be given a system class = -1 (negative class). So there will be 6 training data shown in Table 4 below.

Tabel 4 Training Data Level 1

Student Name	Y	X_1	X_2	X_3	X_4	System Class
Mhs 11	Mild stress	6	4	2	2	1
Mhs 21	Mild stress	4	5	4	3	1
Mhs 9	Moderate Stress	6	7	4	5	-1
Mhs 20	Moderate Stress	5	5	4	5	-1
Mhs 14	High Stress	6	6	6	7	-1
Mhs 22	High Stress	6	5	8	8	-1

2. Level 2 Training Data

In the level 2 training data process, data with a low stress level will not be processed again. So for level 2 training data, the positive system class (1) is shifted to a moderate stress level. Level 2 training data can be shown in Table 5.

Tabel 5. Level 2 Training Data

Student Name	Y	X_1	X_2	X_3	X_4	System Class
Mhs 9	Moderate Stress	6	7	4	5	1
Mhs 20	Moderate Stress	5	5	4	5	1
Mhs 14	High Stress	6	6	6	7	-1
Mhs 22	High Stress	6	5	8	8	-1

3. Level 3 Training Data

For level 3 data training, the threshold of stress is reduced, and the subsequent threshold that becomes a positive system (1) is the threshold of stress. Level 3 data training can be explained in Table 6.

.

Tabel 6. Level 3 Data Training

Student Name	Y	X_1	X_2	X_3	X_4	System Class
Mhs 14	Stres Tinggi	6	6	6	7	1
Mhs 22	Stres Tinggi	6	5	8	8	1

3.5 SVM Testing Process

The testing data used is data other than the training data that has been applied to the previous SVM training process. So based on Table 3, the testing data is selected as in Table 7 below.

Tabel 7. Testing Data

Student Name	Y	X_1	X_2	X_3	X_4
Mhs 60	Stress Ringan	4	3	3	6
Mhs 12	Stres Sedang	7	4	4	8
Mhs 59	Stres Tinggi	6	7	7	5

The calculation process of SVM kernel on the testing data that will be applied in this case is RBF kernel, linear kernel, and polynomial kernel. As an

example of manual calculation, the testing data in Table 7 row 1 is used with SVM level 1 training data in Table 4 rows 1 and 2. So that the results are as follows.

1. RBF Kernel Calculation

Carrying out the RBF kernel calculation process with the formula

$$K(u,v) = e^{(-y||u-v||^2)} \quad (2)$$

For an example of the RBF kernel calculation process using mhs60 and mhs 11 data as follows:

$K = (m_{60}, m_{11}) = e^{(-1(4-6)^2+(3-4)^2+(3-2)^2+(6-2)^2)}$
$= e^{(-1.22)}$
$= e^{-22}$
= 2,789

For example, the RBF kernel calculation process uses mhs60 and mhs 21 data as follows:

$K = (m_{60}, m_{11}) = e^{(-1(4-4)^2+(3-5)^2+(3-4)^2+(6-3)^2)}$
$= e^{(-1.14)}$
$= e^{-14}$
= 8,315

The results of the overall calculation of the RBF kernel value for the 1st level 1 testing data can be seen in Table 8.

Tabel 8 RBF Kernel Testing Data Calculation Results

Id	K(x,y)
1	2,789
2	8,315
3	2,789
4	0,001
5	1,026
6	8,533

2. Linear Kernel Calculation

In the linear kernel calculation, Table 9 and the calculation formula

$$K(u,v) = u.v \quad (3)$$

For an example of linear kernel calculation of mhs60 and mhs11 data as follows

$K = (m_{60}, m_{11}) = (4.6) + (3.4) + (3.2) + (6.2)$
$= 54$

For example, the linear kernel calculation for mhs60 and mhs21 data is as follows

$K = (m_{60}, m_{21}) = (4.4) + (3.5) + (3.4) + (6.3)$
$= 61$

The overall calculation results for the Linear kernel value for level 1 testing data can be seen in Table 9.

Tabel 9 Linear Kernel Testing Data Calculation Results

Id	K(x,y)
1	54
2	61
3	87
4	77
5	102
6	111

3. Kernel Polynomial Calculation

In this kernel polynomial calculation, a polynomial degree 2 will be used, which means the value of p or power = 2. As an example of the calculation, the formula

$$K(u,v) = (1 + u, v)^d, d \geq 1 \quad (3)$$

Example of kernel polynomial calculation for mhs60 and mhs 11 data. As follows:

$K = (m_{60}, m_{11}) = (1 + (4.6) + (3.4) + (3.2) + (6.2))^2$
$= (1 + 54)^2$
$= 3025$

Example of kernel polynomial calculation for mhs60 and mhs 11 data. As follows:

$K = (m_{60}, m_{21}) = (1 + (4.4) + (3.5) + (3.4) + (6.3))^2$
$= (1 + 61)^2$
$= 3844$

The results of the overall calculation of the RBF kernel value for the 1st level 1 testing data can be seen in Table 10.

Tabel 10 Kernel Polynomial Testing Data Calculation Results

Id	K(x,y)
1	3025
2	3844
3	7744
4	6084
5	10609
6	12544

Based on the calculation results of the RBF kernel, linear kernel and polynomial kernel, it can be seen that no kernel produces the least numerical value.

3.6 SVM Classification Results

SVM classification for all data is done using RapidMiner Software. The parameters used in SVM classification using RBF kernel are γ (gamma). The value of the parameter γ (gamma) used is 10−3 , 10−2 , 10−1 , and 1. Accuracy results are shown in Table 11.

Tabel 11 RBF Kernel Accuracy Comparison

Parameter γ	Akurasi
0,001	73,33
0,01	80%
0,1	93,33%
1	76,67%

Based on the table, it shows that the best accuracy is obtained by using the parameter γ = 0.1 with the resulting accuracy value of 93.33%. The results of the confusion matrix with lambda parameter 0.001 are

shown in Table 12, while the lambda parameter 0.01 is shown in Table 13.

Tabel 12 Confusion Matrix With Parameter γ = 0.001

Confusion Matrix		Nilai Aktual		
		True Stress Moderate	True High Stress	True Light Stress
Prediction Value	Medium Stress Pred	22	3	3
	High Stress Pred	0	0	0
	Mild Stress Pred	0	0	0

Based on the confusion matrix of the SVM classification results using the RBF kernel with parameter γ = 0.001 in Table 12, it shows that there are 22 "moderate stress" classes that are correctly predicted as "moderate stress" classes and 3 "high stress" classes are predicted as "moderate stress" classes and 5 "mild stress" classes are predicted as "moderate stress" classes. So that the accuracy calculation is obtained as follows:

$$Accuracy = \frac{22}{22+3+4+1} \times 100\%$$
$$Accuracy = 73{,}33\%$$

Tabel 13 Confusion Matrix With Parameter γ = 0.01

Confusion Matrix		Nilai Aktual		
		True Stress Moderate	True High Stress	True Light Stress
Prediction Value	Medium Stress Pred	22	3	3
	High Stress Pred	0	0	0
	Mild Stress Pred	0	0	2

Based on the confusion matrix of the SVM classification results using the RBF kernel with parameter γ = 0.01 in Table 13, it shows that there are 22 "moderate stress" classes that are correctly predicted as "moderate stress" classes and 3 "high stress" classes are predicted as "moderate stress" classes and 3 "mild stress" classes are predicted as "moderate stress" classes and 2 "mild stress" classes are correctly predicted as "mild stress" classes. So that the accuracy calculation is obtained as follows:

$$Accuracy = \frac{22+2}{22+3+3+2} \times 100\%$$
$$Akurasi = 80\%$$

Tabel 14 Confusion Matrix With Parameter γ = 0.1

Confusion Matrix		Nilai Aktual		
		True Stress Moderate	True High Stress	True Light Stress
Prediction Value	Medium Stress Pred	22	1	1
	High Stress Pred	0	2	0
	Mild Stress Pred	0	0	4

Based on the confusion matrix of the SVM classification results using the RBF kernel with parameter γ = 0.1 in Table 14, it shows that there are 22 "moderate stress" classes that are correctly predicted as "moderate stress" classes, there is 1 "high stress" class predicted as "moderate stress" class, and 2 "high stress" classes that are correctly predicted as "high stress" classes and 1 "mild stress" class predicted as "moderate stress" class and 4 "mild stress" classes that are correctly predicted as "mild stress" classes. So that the accuracy calculation is obtained as follows:

$$Akurasi = \frac{22+2+4}{22+1+1+2+4} \times 100\%$$
$$Akurasi = 93{,}33\%$$

Tabel 15 Confusion Matrix With Parameter γ = 1

Confusion Matrix		Nilai Aktual		
		True Stress Moderate	True High Stress	True Light Stress
Prediction Value	Medium Stress Pred	22	3	4
	High Stress Pred	0	0	0
	Mild Stress Pred	0	0	1

Based on the confusion matrix of the SVM classification results using the RBF kernel with parameter γ = 1 in Table 15, it shows that there are 22 "moderate stress" classes that are correctly predicted as "moderate stress" classes and 3 "high stress" classes are predicted as "moderate stress" classes and 4 "mild stress" classes are predicted as "moderate stress" classes and 1 "mild stress" class is correctly predicted as "mild stress" class. So that the accuracy calculation is obtained as follows:

$$Accuracy = \frac{22+1}{22+3+4+1} \times 100\%$$
$$Accuracy = 76{,}67\%$$

3.7 RapidMiner Implementation

RapidMiner is a data-set processing software to find data patterns according to the purpose of data processing. Figure 2 is a classification model created using RapidMiner.

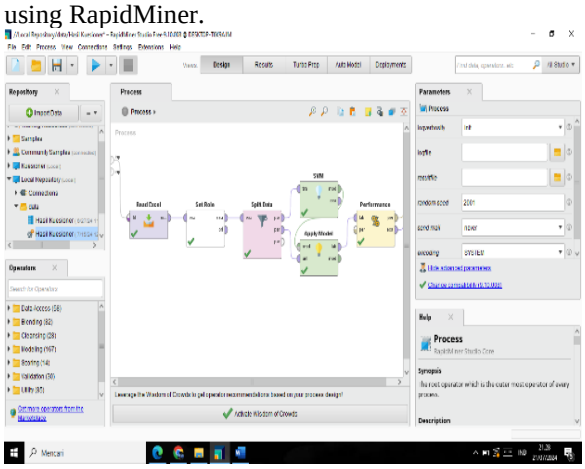

Figure 2 Classification Process Model

The best accuracy result is obtained in Figure 3 using a parameter γ = 0.1 with an accurate value of 93.33%.

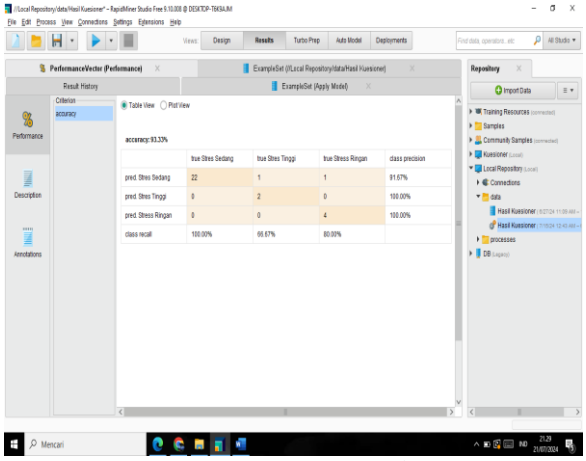

Figure 3 Parameter Accuracy Results γ = 0.1

4. CONCLUSION

Based on the results of the study, it can be concluded that the RBF (Radial Basis Function) kernel is the most optimal for use in the SVM method, producing minimal numerical values with parameters γ = 1. The dataset in this study was divided with a ratio of 80:20, where 121 data (80%) were used as training data and 30 data (20%) as test data. Of the 151 student data collected, 71.5% (108 students) were in the moderate stress category, 17.2% (26 students) in the mild stress category, and 11.2% (17 students) in the high stress category. The results of the SVM classification applied using RapidMiner showed the best accuracy of 93.33%.

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