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Application of the support vector machine algorithm in the classification of livable houses

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ABSTRACT

Home is a basic need for humans in living life. Humans need a house to live and mingle with family. Having a decent home is the dream of every family. However, due to economic limitations, livable houses are difficult to realize. The government made the Rutilahu (Uninhabitable House) policy to reduce the number of uninhabitable houses. However, in practice there are still many misdirected targets. The Village Government is still carrying out the data classification process manually to determine which houses are livable and which are not. Processes that are still manual are old and inaccurate. For this reason, it is necessary to have a system to classify suitable and ineligible houses using the Support Vector Machine algorithm to make it more detailed so that later the assistance will not be misdirected. Support Vector Machine is a technique for maximizing margins, namely the distance that separates data classes by finding the best hyperplane. Determination of the classification of livable houses is based on four main indicators, namely the structure of the building, its area, sanitation, and clean water. This study took 642 data with 513 training data and 129 testing data and by using validation techniques using the confusion matrix obtained an accuracy of 80%. Thus the system built with the Support Vector Machine algorithm is quite good in the classification of livable houses.

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1. INTRODUCTION

One of the macroeconomic problems that is still ongoing today, including in Indonesia, is poverty (Iman & Wahyu, 2021). Poverty is not just about the problem of being unable to find primary needs such as food but also a place to live (Aji et al., 2020).

The inability to fulfill basic needs, especially shelter/shelter or a habitable house, causes poor families to be unable to function properly (Yoga Tursilarini & Trilaksmi Udiati, 2020). In improving human needs, the most basic is a house. The house must be clean, comfortable, safe and livable (Agustina et al., 2018). A house is a building that functions as a habitable residence, a means of family development, social status identity, and as an asset for its owner (Elvira & Badrah, 2023). A house or shelter is a basic need for humans apart from food and clothing (Wahab, 2019). Having a decent house has become the dream of every family. Not only is it suitable for housing, but it must also fulfill several factors. In the SDGs (Sustainable Development Goals) it is explained that a house that is livable must meet 4 factors or criteria and all of them must be met. These four factors are the structure of the building, its area, sanitation, and clean water (Aunurrofiq et al., n.d.). Livable houses are difficult for poor people to create due to economic limitations.

The Ministry of Social Affairs states that the criteria for a house that is unfit for habitation is a house made from wooden boards or plywood, because this material is considered not durable (M Prawirosusanto, 2021). Unfit for habitation, hereinafter abbreviated as RTLH, is a house that does not meet building safety requirements, sufficient minimum building area, and occupant health (Khairuni et al., 2022). As an effort to overcome the increasing number of uninhabitable houses, the government created the Rutilahu (Uninhabitable Houses) policy. However, in practice, the provision of assistance to the community is uneven. Suka Damai Village, Kec. Sei Bamban District. Serdang Bedagai is one of the areas that received this assistance. The Suka Damai Village Government is still carrying out a manual data classification process to determine which houses are suitable for habitation and which are not suitable for habitation when providing assistance, even though the data processed is quite large, namely 642 residents. Processes that are still manual are considered long and inaccurate, so there is still a lot of aid that is misdirected (Khasanah, 2019). Therefore, a system is needed to classify houses as habitable and uninhabitable houses based on predetermined criteria.

Based on the problems above, researchers conducted research on classifying habitable houses using the support vector machine algorithm. The generalization and classification capabilities of the support vector machine are very strong. Support Vector Machine is a machine learning algorithm based on structural risk minimization (SRM). The goal is to find the optimal hyperplane in the input space that divides the two class items (Isa et al., 2022). The operating principle of the Support Vector Machine can only effectively classify two classes, but it is designed to classify more than two classes using pattern recognition (Darnila et al., 2019). By measuring the margin of the hyperplane and finding its maximum point, the ideal hyperplane to separate the two classes can be identified (Susilowati et al., 2015). Based on the description above, the researchers took the title "Classification of Livable Houses Using the Support Vector Machine Algorithm".

2. RESEARCH METHOD

In the research methodology there is a research plan. According to (Mardawani, 2020) a research plan is a framework or sketch designed by the researcher as a research plan. This research plan includes planning, techniques for collecting data, needs analysis, system design, testing and application/usability. The stages of the research plan in this study are as follows:

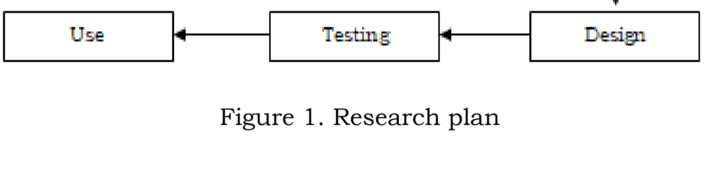


Figure 1. Research plan

2.1 Research plan

a. Planning

This stage includes the first to determine the topic of the problem to be raised. Second, to determine the object of research, Suka Damai Village, Sei Bamban District, Serdang Bedagai Regency was chosen as the research object. The third is the formulation of the problem by determining what problems are being studied along with the scope or limitations of the problem. Fourth determination of the title. Fifth, the determination of objectives to clarify what is the target of this research

b. Data Collection Techniques

In book (Ghaniaviyanto Ramadhan & Khoirunnisa, 2021) it states that data collection techniques are methods used in the field to collect information or facts. In this study used secondary data, secondary data is the type of data that has been collected by other parties or organizations for a specific purpose (Sukmawati et al., 2023). The secondary data for this research comes from the Integrated Social Welfare Data (DTKS) at the Suka Damai Village Head Office. From the data collection process, a total of 642 families (family cards) were obtained, this data was taken from 2017-2022.

c. Needs Analysis

Needs analysis aims to analyze the problem (Jakaria et al., 2019). This stage is carried out to obtain information on what needs are needed in the research to classify the status of houses that are included in the " habitable " and " Uninhabitable houses" groups. Then in the needs analysis stage, which includes analysis of hardware and software requirements. The software used in building this system is an application designed using the web-based PHP programming language and a database using MySQL.

d. Design

Design diagram for SVM Algorithm classification using UML. UML (Unified Modeling Language) is applied to design software and document existing systems. Researchers use UML which includes Use Case Diagrams to describe actor interactions with the system. Activity Diagram to describe the sequence of system processes that are being designed.

e. Testing

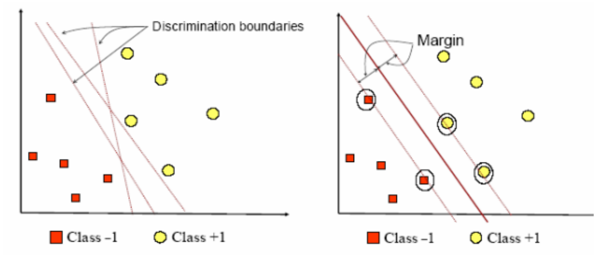
Testing means the process of checking whether the software produced can be executed according to certain expected standards (Setyawati et al., 2023). Utilization of the Support Vector Machine algorithm for testing the livable housing classification aims to test the system validation value to determine the accuracy of the livable housing classification system. Accuracy testing is done by comparing the system output with the dataset.

f. Usage

The village government can easily use this system to categorize houses as livable or uninhabitable based on existing criteria. The process of building a system using existing designs and literature is known as implementation.

2.2 Support Vector Machine

Support Vector Machine (SVM) is a technique for maximizing the margin, namely the distance that separates data classes. The basic concept of SVM is to separate two classes of data by finding the best hyperplane (Werdiningsih et al., 2020).



(a) (b)

Figure 2. SVM Finding optimal hyperplane to separate between two class -1 and +1

There are two classes of patterns depicted in Figure 2(a):+1 and -1. The red color (box) represents the pattern in the class -1 category. In contrast, patterns in class +1 are represented by yellow circles. Try to find the line (hyperplane) that divides the two groups to understand the classification problem (Fikriani et al., 2019).

The svm calculation stages start from sequential training, sequential training on the other hand takes less time and uses a simpler algorithm. The Sequential Training algorithm is as follows: (Vijayakumar S, 1999)

First, initialize αi and other parameters, namely λ, C, and ε. Second, calculate the Hessian matrix.

$$D_{ij} = y_i y_j \left(K\left(x_i x_j\right) + \lambda^2 \right) \quad (1)$$

Third, use equations 2, 3, 4 to calculate the processes Ei, δαi and αi on the data used starting from data i to j.

$$E_i = \sum_{j=1}^{n} \alpha_j D_{ij} \quad (2)$$

$$\delta\alpha_i = \min\{max[\gamma(1 - E_i), \alpha_i], \ C - \alpha_i\} \quad (3)$$

$$\alpha_i = \alpha_i + \delta\alpha_i \quad (4)$$

The four processes Ei, δαi and αi are carried out repeatedly until max ([δαi]) < ε or as long as the maximum iteration condition is reached. Then finally get the support vector (SV) value, SV= (αi >ThresholdSV), by giving the value ThresholdSV = 0. Testing is the testing stage of the Support Vestor Machine algorithm. The testing stage is carried out to find the f(x) value or classification results.

$$f(x) = \sum_{i=1}^{n} \alpha i y j \; K(xi, x) + b \quad (5)$$

3. RESULTS AND DISCUSSIONS

3.1 Data Analysis

This data analysis will provide an explanation of the rules and criteria used to classify livable houses as initial information in the calculation of the SVM algorithm. This study uses 15 criteria to determine whether a house is livable.The 15 criteria come from the Integrated Social Welfare Data (DTKS), each criterion has a value that will later be used as a calculation.

3.2 Example of Support Vector Machine algorithm calculation

After carrying out the data analysis stage, it then explains how the SVM algorithm is used to classify livable houses using manual calculations. SVM manual estimation has several stages. The first of these stages is known as normalization, the second is known as sequential training calculation, and the third is known as testing.

3.3 Data Transformation

Data transformation is the process of changing or converting data into a new scale to fulfill the normal data distribution (Lasmiatun et al., 2023). Data transformation is made to simplify SVM calculations, along with the results of data transformation of the selected attributes based on the principles of Social Welfare Data (DTKS).

Table 1. Training Data

No	Data	01	02	03	04	05	...	13	14	15	16
1	8	Agriculture	550	SD	Own	60	...	Firewood	Alone	Tank	Not worth it
2	11	Horticulture	3500	Junior High School	Own	70	...	Firewood	Alone	Tank	Worthit
3	53	Processing industry	2500	SD	Own	54	...	gas 3 kg	Alone	Tank	Worthit
4	60	Trading	600	Senior High School	Rent Free	36	...	gas 3 kg	Alone	Tank	Not worth it
5	100	Processing industry	2900	SD	Own	90	...	gas 3 kg	Alone	Tank	Worth it
6	105	Processing industry	3000	Junior High School	Rent Free	63	...	Firewood	Alone	Tank	Worth it
7	129	transportation and warehousing	2500	Junior High School	Own	55	...	gas 3 kg	Alone	Ground pit	Worth it
8	157	Building	3500	SD	Own	54	...	gas 3 kg	Alone	Tank	Worth it
9	212	social Services	900	Senior High School	Own	36	...	gas 3 kg	Alone	Tank	Not worth it
10	480	Building	750	SD	Own	21	...	Firewood	There isn't any	Ground pit	Not worth it

In table 1 is the dataset used in this calculation. The dataset consists of 642 data that will be used in system implementation into 15 randomly selected data sets for the data set used to calculate the Support Vector Machine algorithm. In table 1 is training data which contains the criteria for determining a habitable house. 10 sets of training data were taken from the total dataset as calculation examples.

Table 2. Testing Data

No	Data	01	02	03	04	05	...	13	14	15	16
1	28	electricity and gas	2500	SD	Rent Free	48	...	gas 3 kg	Alone	Tank	Worth it
2	541	Agriculture	500	SD	Own	35	...	Gas 3 kg	Alone	Ground pit	Not worth it
3	557	Agriculture	500	SD	Rent Free	24	...	gas 3 kg	Alone	Ground pit	Not worth it
4	622	Agriculture	800	Senior High School	Rent	16	...	gas > 3 kg	Alone	Tank	Not worth it
5	640	Other	500	SD	Own	15	...	gas 3 kg	There isn't any	Pool	Not worth it

In table 2 is the test data that will be used later in this calculation. The test data uses 5 randomly selected data based on the original dataset. Test data also contains the criteria used in classifying a house as habitable. There are 15 criteria in determining the classification of a house as habitable. The test data will later produce manual calculations in determining classification.

Data from tables 1 and 2 will then be converted to facilitate the calculation process. The results of the table data that has been transformed into data and determined by class can be seen in the table below.

Table 3. Transformation Training Data

Data	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
8	1	1	1	1	60	6	3	6	3	6	3	1	3	1	1	-1
11	2	2	7	1	70	2	1	6	2	6	3	1	3	1	1	1
53	9	2	1	1	54	6	1	6	2	6	3	1	3	1	1	1
60	9	1	7	3	36	9	6	6	2	7	3	1	8	4	4	-1
100	12	2	1	1	90	2	1	6	3	5	3	1	3	1	3	1
105	9	2	4	3	63	6	1	6	2	6	3	1	3	4	5	1
129	14	2	4	1	55	6	1	6	2	2	1	1	3	1	1	1
157	11	2	1	1	54	6	6	6	2	5	3	1	8	1	1	1
212	19	1	7	1	36	6	4	6	1	2	2	1	3	1	1	-1
480	11	1	1	1	21	6	1	4	1	6	3	3	8	4	3	-1

In table 3 is the training data that has been transformed into numerical data so that it shows the value of each criterion. To make it easier to use the support vector machine algorithm in calculations, training and testing data will each get a weight value based on parameters. The weight value is generated by the parameter values for each criterion in the original data based on DTKS data.

Table 4.Transformation Testing Data

Data	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
28	10	2	1	3	48	2	1	2	5	5	3	1	3	1	1	1
541	1	1	1	1	35	6	4	6	2	6	1	1	3	1	3	-1
557	1	1	1	3	24	6	3	6	1	6	3	3	3	1	3	-1
622	1	1	7	2	16	6	1	6	1	2	1	1	2	1	1	-1
640	21	1	1	1	15	6	4	6	2	2	1	1	3	4	4	-1

In table 4 is test data that has been transformed into numerical data so that it shows the value for each criterion. Similar to training data, test data is transformed based on the weight values of the original data parameters. Criterion A16 shows a value of 1 as an appropriate class and -1 as an ineligible class. After the data has been transformed, manual calculations can be carried out and then normalized.

3.4 Data Normalization

Data normalization is to make all features have a uniform range scale, usually by changing the values to be centered around zero (Kurniawan, 2020). After the data is initialized and the class is determined, the next step is to calculate the normalization value for each data. to calculate it using the following formula.

$$Norm = (\frac{Xlama - Xmin}{Xmax - Xmin}) \quad (6)$$

$Norm_{1,1} = \frac{1-1}{19-1} = 0$

$Norm_{21} = \frac{2-1}{19-1} = 0.05555556$

a. Manual Linear Kernel Calculations

The linear kernel is one of the simplest and most commonly used kernel types in machine learning. In other words, this kernel only performs ordinary sums between the data being analyzed (Muhammad et al., 2023). Below is an example of a linear kernel calculation.

$$K(x,y) = x.y \quad (7)$$

K=(0×0)+(0×0)+(0×0)+(0×0)+(0.565217391×0. 565217391) + (0.571428571×0.571428571) +(0.4×0.4)+(1×1)+(1×1)+(0.8×0.8)+(1×1)+(0×0)+(0×0)+(0×0)+(0×0)
= 4.446001312

b. Calculation of Sequential Training

Data training has the aim of training the machine with learning stages so that it can study data of unknown type and obtain the resulting accuracy as optimally as possible (Furqan et al., 2020). The training calculation steps are as follows:

a. Perform initialization of αi and other parameters, namely $\lambda,\boldsymbol{\gamma}$, C, and ε

αi = 0 ε= 0,001 γ = 0,01 λ = 0.5 C = 1

c. Performing Hessian Matrix Calculations

The initial step in the sequential training process is the calculation of the Hessian matrix, which utilizes an initialization value of 0.5 lambda. For 10 training data, the Hessian matrix is calculated by multiplying 3 values, namely class of row data, class of column data, and lambda values squared using the information in data normalization.

For 1st row 1st column:

D_{11}= 1×1 (4.446001312 + 0.5^2)= 4.696001312

d. The Sequential Training SVM method is used to calculate the error value from the Hessian matrix value.

$$E_1 = 1\times 0 \times 4.696001312 = 0$$

e. Calculating the Value of $\delta\alpha i$

The gamma value can be obtained from the CLR or by dividing the learning rate constant 0.01 by the maximum value of the Hessian matrix diagonal, which is 10.3072898 . Thus, the gamma value obtained is 0.000970187. The C value is also initialized to 1 when the delta alpha value is calculated.

MaxDi = The maximum value of the hessian matrix

$\delta\alpha i$ = min{max[0.000970187 (1 − 0), -0], (1 – 0)} = 0.000970187

f. Calculating αi Values

At this time by combining the initial alpha value with the alpha delta value obtained in the previous step.

αi = 0 + 0.000970187= 0.000970187

g. Calculation of Testing SVM

By using the normalized test data in Table 6, a testing process will be carried out after the training process is complete. The purpose of the testing process is to get the results of the classification and the value of f(x). 5 data used for testing.

$K\,(\boldsymbol{x_1}, x)$ = ((0×0.45)+(0×1)+(0×0)+(0×1)+(0.565217391×1)+(0.571428571×0)+(0.4×0)+(1×0) +(1×1)+(0.8×0.75)+(1×1)+(0×0)+(0×1)+(0×0)+(0×0)
= 3.165217391

After the value of K (xi, x) is obtained, the next process is to find the value of f (x).

f (x) = (-5.36144E-06×1×3.165217391)+(-4.50995E-06×1×3.835144928)+(-4.69394E-06 × 1×3.77826087)+(-5.31277E-06×1×4.667391304)+(-4.98419E-06×1× 4.725) + (-4.76333E-

06×-1×4.908695652)+(-3.15798E-06×-1×2.317753623)+(-4.91984E-06×-1×3.415217391)
+(-3.23738E-06×-1×1.167391304)+(-3.0276E-06×-1×2.85)
= 0.00016026

The final stage is to find the value of the classification function as follows:
Classification Function = *Sign f (x)*
= *Sign f* (0.00016026) = 1

Table 5. Classification Results and Actual Class

Data	Value f (x)	Sign f (x)	Classification Results	Actual Class
1	0.00016026	1	Worth it	Worth it
2	-2.48908E-05	-1	Not Worth it	Not Worth it
3	-4.37625E-06	-1	Not Worth it	Not Worth it
4	-3.54905E-05	-1	Not Worth it	Not Worth it
5	-2.04407E-05	-1	Not Worth it	Not Worth it

Table 5 shows the results of SVM testing calculations with a comparison of classification results with manual support vector machine calculations and actual classes. All test data used in the process of calculating results to obtain classification results. The number 1 indicates a feasible classification result, while the number -1 indicates an unfit classification result.

Table 6. Comparison of manual and system

Data	Name	Manual	System	information
28	Samsul	Worth it	Worth it	Exactly
541	Jumakir	Not Worth it	Not Worth it	Exactly
557	Rauman Boru Sianturi	Not Worth it	Worth it	not exactly
662	Pasaman Situngkir	Not Worth it	Not Worth it	Exactly
640	Hermadi	Not Worth it	Not Worth it	Exactly

Table 6 shows a comparison of classification results using manual support vector machine calculations with classification results using the system. It can be seen that the correct data from the test data in the system is 4 and the incorrect data is 1. Where all the correct data is in accordance with the original dataset class, while the incorrect data is the data on the status of residents' houses tested with the system which gets decent results.

Table 7. confusion matrix accuracy results

Precision	Recall	F1-Score	Accuracy
0.75	0.875	0.807	80%

Table 7 shows the confusion matrix of 5 sample data tested with the SVM model using 10 training data and 5 test data with 15 criteria, obtaining an accuracy of 80%. Accuracy is obtained by the formula for the correct amount of data divided by the total amount of data multiplied by 100 percent

The test findings showed that the system accuracy calculation using original data calculations received an accuracy value of 80% with a data ratio ratio of 80%:20%. Meanwhile, the accuracy of the training data obtained 100% accuracy results. Based on the tests that have been carried out, it can be stated that the support vector machine algorithm is a good algorithm for classifying habitable houses. This is due to the unequal distribution of data because in the data set the comparison between feasible and unfeasible is too far apart.

3.3 Program Results

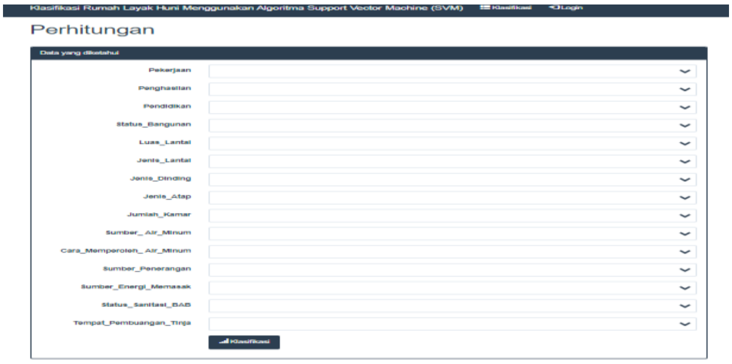
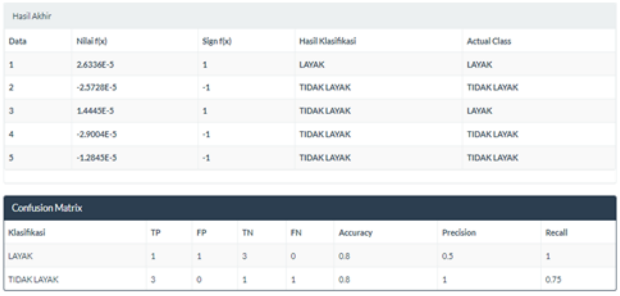


Figure 3. Classification

Figure 3 shows the classification menu page which contains the criteria used in the classification. On the classification page the user can input any criteria that are determining in classifying the available habitable houses and carry out the classification, the system will display the classification results based on the criterian that the user has input.



Hasil Akhir

Data	Nilai f(x)	Sign f(x)	Hasil Klasifikasi	Actual Class
1	2.6336E-5	1	LAYAK	LAYAK
2	-2.5728E-5	-1	TIDAK LAYAK	TIDAK LAYAK
3	1.4445E-5	1	TIDAK LAYAK	LAYAK
4	-2.9004E-5	-1	TIDAK LAYAK	TIDAK LAYAK
5	-1.2845E-5	-1	TIDAK LAYAK	TIDAK LAYAK

Confusion Matrix

Klasifikasi	TP	FP	TN	FN	Accuracy	Precision	Recall
LAYAK	1	1	3	0	0.8	0.5	1
TIDAK LAYAK	3	0	1	1	0.8	1	0.75

Figure 4. Classification test results

Figure 4 shows the classification system by taking samples of data which are used for manual calculations and validation results with a confusion matrix. It can be seen that there are differences in the results of the classification system and the original data. The validation results with the confusion matrix show that the test has four correct data and one incorrect data.

4 CONCLUSION

This study uses 15 criteria that can be used to classify livable houses using the Support Vector Machine Algorithm, namely: Occupation, Income, Education, Building status, Floor area, Type of floor of the house, Type of walls, Type of roof, Number of rooms, Source of drinking water, Method access to drinking water, electricity, cooking fuel, toilets and excreta disposal sites. In the classification of livable houses using the Support Vector Machine Algorithm, it produces two classes of data, namely feasible and not feasible. This study took 642 data with 513 training data and 129 testing data. The test results using the validation technique using the confusion matrix obtained an accuracy of 80%.

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