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APPLICATION OF PARTICLE SWARM OPTIMIZATION SUPPORT VECTOR MACHINE FOR ELECTRICAL INSTALLATION CERTIFICATION PREDICTION

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Abstract: Feature selection is a crucial process that is very important to improve the performance of machine learning models, in accordance with data preprocessing. The feature selection process can be considered as a global combinatorial optimization problem in machine learning, which reduces the number of features, eliminates irrelevant data, and produces acceptable classification accuracy. The purpose of this study is to predict or determine the results of the electrical installation operation feasibility test based on data and obtain attribute selection features, and obtain accuracy level results. The Particle Swarm Optimization (PSO) approach is used to select the right characteristics to determine the results of the electrical installation operation feasibility test because attribute selection is needed in data analysis, because the PSO method will increase accuracy than just SVM in determining attribute selection. If SVM is used with PSO, the accuracy value is 96% and AUC is 0.994%, while the SVM method produces an accuracy level of 94.89% and AUC of 0.994%. With this finding, the accuracy value increases by 2%, making it a very good categorization category. It has been proven that the use of Particle Swarm Optimization (PSO) based algorithms can improve and improve results.

Keywords: PSO; SVM; Certification

Abstrak: Pemilihan fitur merupakan proses krusial yang sangat penting untuk meningkatkan kinerja model machine learning, sesuai dengan praproses data. Proses pemilihan fitur dapat dianggap sebagai masalah optimasi kombinatorial global dalam pembelajaran mesin, yang mengurangi jumlah fitur, menghilangkan data yang tidak relevan, dan menghasilkan akurasi klasifikasi yang dapat diterima. Tujuan dari penelitian ini adalah untuk memprediksi atau menentukan hasil uji kelayakan operasi instalasi listrik berdasarkan data dan memperoleh fitur pemilihan atribut, serta memperoleh hasil tingkat akurasi. Pendekatan Particle Swarm Optimization (PSO) digunakan untuk memilih karakteristik yang tepat untuk menentukan hasil uji kelayakan operasi instalasi listrik karena pemilihan atribut diperlukan dalam analisis data, karena metode PSO akan meningkatkan akurasi dari pada hanya SVM dalam menentukan pemilihan atribut. Jika SVM digunakan dengan PSO, nilai akurasinya adalah 96% dan AUC sebesar 0,994%, sedangkan metode SVM menghasilkan tingkat akurasi sebesar 94,89% dan AUC sebesar 0,994%. Dengan temuan ini, nilai akurasi meningkat sebesar 2%, menjadikannya kategori kategorisasi yang sangat baik. Telah terbukti bahwa penggunaan algoritma berbasis Particle Swarm Optimization (PSO) dapat meningkatkan dan memperbaiki hasil.

Kata kunci: PSO; SVM; Sertifikasi

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INTRODUCTION

Feature selection provides instructions for selecting a subset of features, also called variables, which can help to build an efficient model to describe a subset to be selected. [1]. Although there is a little distinction between feature selection and extraction, both are frequently used to identify the variables (i.e., features) that are important for comprehending and analyzing data. [2]. The selection of attributes can have an influence in predicting data. [3]. In addition, in selecting attributes, you can also determine the values in the data set [4].

In data preprocessing, feature selection is an important process that involves selecting the most relevant features to improve the performance of a machine learning model. Effective feature selection can result in more accurate predictions, reduced overfitting, and increased computational speed [5].

Work involving electrical installation calls for advanced abilities, Electrical installation work necessitates accuracy and adherence to laws in addition to knowledge and abilities. [6].
Electrical technology is one of the fields that has experienced acceleration in development. Currently, electrical energy is an important consumption for human life because it is needed by various industries, businesses, and daily activities.

The government has set regulations for the installation and use of electricity to ensure adequate electricity availability. The government has established the Low Voltage Engineering Inspection Agency (TR) as part of this effort. The LIT's task is to conduct inspections and provide digital-based Operational Certificates (SLO) to electricity users.[7]. A certificate of suitability for an electrical installation is proof of formal recognition given by the government to the owner of a building or residence through an electrical installation issued by an electrical engineering institution recognized by the government.[8].

This study aims to provide knowledge about machine learning, obtain selection features, and obtain accuracy level results from operational feasibility test results at the Electrical Engineering Inspection Institute. Of all the features that can affect the results of the feasibility test, researchers try to identify which features have the most significant value in influencing the success of the feasibility test of the engineering inspection institution. Therefore, researchers make efforts to use machine learning algorithms with the Support Vectore Machine algorithm.

The Machine of Support Vectors When faced with restricted samples, the theory of algorithms can offer a more potent theoretical framework for researching statistical pattern recognition and a broader variety of machine learning issues[9]. Text classification has found SVM to be highly successful because to its ability to handle high-dimensional data through the use of kernels [10].

The feature selection process can be considered as a global combinatorial optimization problem in machine learning, which reduces the number of features, eliminates irrelevant data, and produces acceptable classification accuracy. Feature selection is very important in classification with a large number of attributes to perform attribute selection[11], because feature selection is a basic technique and is widely used to handle large data[12]. In addition, the selection feature can handle the problem of overfitting models on high-dimensional data sets. [13].

However, to perform attribute se-

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lection, the SVM algorithm alone is not enough, therefore, to implement attribute selection, the Particle Swarm Optimization (PSO) method must be combined with the SVM algorithm. In the context of Support Vector Machine models without optimization, overfitting tends to occur due to the lack of effective mechanisms to manage complexity and feature selection. However, by using PSO optimization, the overfitting problem can be addressed by finding a subset of relevant attributes, eliminating unimportant attributes, and reducing model complexity.[14]

So to determine the results of the electrical installation certification, the author uses particle swarm optimization. By comparing the application of the Particle Swarm Optimization algorithm, the algorithm can optimize it. The PSO algorithm is considered the main Swarm Intelligence technique that shows good performance in solving various optimization problems[15].

The calculation of the PSO method will be done by comparing it. Particle Swarm Optimization (PSO) is a classic meta-heuristic algorithm that is popularly used in many real-world optimization problems due to its lower computational complexity[16]. The results of previous research have been applied using Particle Swarm Optimization (PSO). The results of the research show that PSO shows the highest level of performance [17].

METHOD

This research method explains how the steps used in implementing PSO to find the results of operational feasibility tests in an institution using SVM and Particle swarm optimization (PSO) will be used to be able to implement feature selection. The following are the results of the research framework, which can be seen in Figure 1.

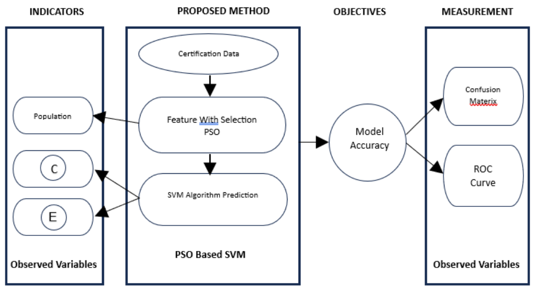

Figure 1. research framework

Support Vectore Machine

A support vector machine, or SVM, divides a training set into many classes using a surface that maximizes the margin. Stated differently, SVM makes it possible to maximize a model's capacity for generalization.[18].
Training an SVM requires a set of n examples. Each example consists of a pair, an input vector xi and an associated label yi. The assumptions are as follows:

$$(\mathbf{x}_1, \mathbf{y}_1), (\mathbf{x}_2, \mathbf{y}_2), \ldots, (\mathbf{x}_n, \mathbf{y}_n) \quad (1)$$

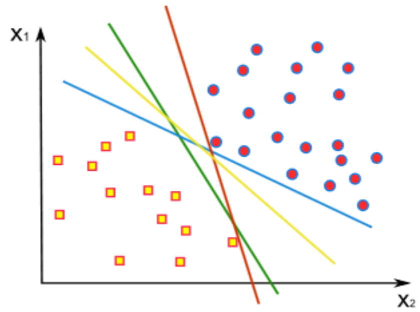

Figure 2. SVM [18]

$$\langle \mathbf{w} \cdot \mathbf{x}^{+} \rangle + b = 1$$
$$\langle \mathbf{w} \cdot \mathbf{x}^{-} \rangle + b = -1 \quad (2)$$

These can be combined into a set of inequalities: where b is the bias and w is the ideal separation hyperplane. The margin is the separation between the hy-

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perplane and the training data that is closest to the hyperplane.

$$y_i(\langle w \cdot x_i\rangle + b) \geq 1 \forall i \quad (3)$$

The geometric limits of x^+ y x^- is :

$$\begin{aligned}\gamma_i &= \tfrac{1}{2}\left(\left\langle \tfrac{w}{\|w\|}\cdot x^+\right\rangle - \left\langle \tfrac{w}{\|w\|}\cdot x^-\right\rangle\right)\\ &= \tfrac{1}{2\|w\|}[\langle w\cdot x^+\rangle - \langle w\cdot x^-\rangle]\\ &= \tfrac{1}{\|w\|}\end{aligned} \quad (4)$$

Where w defines the optimal separating hyperplane and b as the bias. The distance between the hyperplane and the training data closest to the hyperplane is called the margin. The generalization ability is maximized if the optimal separating hyperplane is chosen as the separating hyperplane.

Particvle Swarm Optimization

The Particle Swarm Optimization algorithm starts by generating a random solution for each particle and assigning it an initial velocity. [19]. This algorithm imitates the communication behavior of a group of flocks, such as birds or schools of fish.

As particles move, their current positions *i* symbolized by a vector $x_i = (x_{i1}, x_{i2}, \ldots, x_{iD})$ where *D* indicates the dimensionality of the search space. Meanwhile, the velocity *i* is denoted by the formula as $v_i = (v_{i1}, v_{i2}, \ldots, v_{iD})$ A predetermined maximum speed limits the particle speed so that v_{max} and $v_{id}^t \in [-v_{max}, v_{max}]$. Furthermore, the best position of the particle in the past is documented as the private best position and is denoted as pbest. Thus, the best location achieved by the swarm is called *"global best"* or *"gbest"* [19]. PSO search and find the ideal solution by updating the particles using (1) and (2) used to calculate the moving speed as follows [20].

$$x_{id}^{t+1} = x_{id}^t + v_{id}^{t+1} \quad (5)$$

$$v_{id}^{t+1} = w \times v_{id}^t + c_1 \times r_{1i} \times (p_{id} - x_{id}^t) + c_2 \times r_{2i} \times (p_{gd} - x_{id}^t) \quad (6)$$

RESULTS AND DISCUSSION

Test Results with Support Vector Machine Method

The following figure shows the results of testing the support vector machine (SVM) algorithm using RapidMiner. The results of searching using the Support Vector Machine (SVM) method are shown as follows:

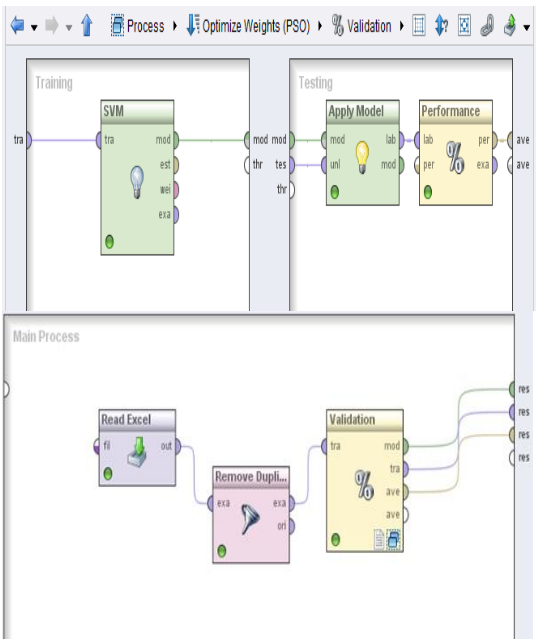

Figure 3. SVM Algorithm Testing

After testing was carried out in rapidminer software using the SVM method from the confusion matrix, the results were True Positive (TP) of 77 which were classified as 1 according to the SVM method prediction; results (FN)

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5 data predicted as 1 turned out to be 2, and the results of False Positive (FP) 0 data predicted as 2 but turned out to be 1. Below, table 1 shows this.

Table 1. Confusion Matrix Result

	Predicted Class	
	Class=1	Class=2
Class=1	77	5
Class=2	0	17

The accuracy of SVM is 94.89% with an auc value of 0.994%, and can produce accuracy, sensitivity, specificity, ppv, and npv values, as shown by the following calculation:

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} = \frac{77+17}{77+17+0+5} =$$

$$0.94$$

$$\text{Sensitivity} = \frac{TP}{TP+FN} = \frac{77}{77+5} = 0.9390$$

$$\text{Specificity} = \frac{TN}{TN+FP} = \frac{17}{17+0} = 1$$

$$\text{PPV} = \frac{TP}{TP+FP} = \frac{77}{77+0} = 1$$

$$\text{NPV} = \frac{TN}{TN+FN} = \frac{17}{17+5} = 0.772$$

The above calculation yielded results with an accuracy of 94% and values for accuracy, sensitivity, certainty, ppv, and npv using the SVM algorithm.

PSO results using the Support Vector Machine method.

The following table presents the results of the PSO algorithm's support vector machine (SVM) evaluation using RapidMiner. The results of the search are as follows:

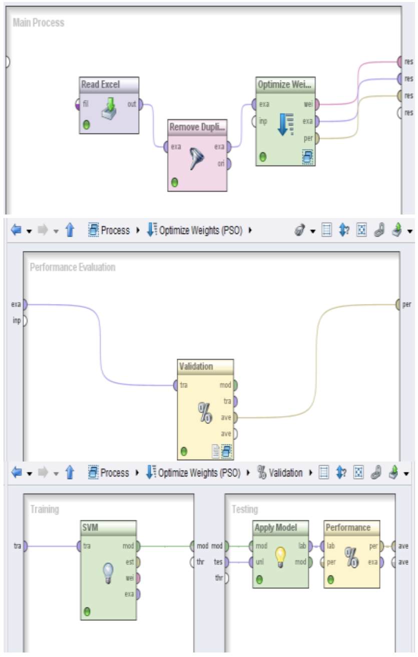

Figure 4. Testing with the application of Particle Swarm Optimization (PSO) to the SVM method.

Table 2 presents the results of the PSO evaluation of the SVM method from Matriks. Value (TP) is 77 in classification as 1 according to SVM prediction, and (FN) is 18 according to SVM prediction, but at it turns out 2, lalu (TN) is 0 data as 2 according to what is predicted, and (FP) is 4 data according to what is predicted 2 according to what is stated 1. Subsequently, the SVM algorithm with PSO implementation yielded an accuracy of 96% and an AUC of 0.994%. Five of the seven attributes in image 4.7 are detrimental since the values of the five attributes are the highest at 0.5. Using the following calculation, accuracy value, sensitivity, specificity, ppv, and npv can be determined:

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Table 2. Confusion Matrix Results

	Predicted Class	
	Class=1	*Class*=2
Class=1	77	4
Class=2	0	18

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} = \frac{77+18}{77+18+0+4} = 0.96$$

$$\text{Sensitivity} = \frac{TP}{TP+FN} = \frac{77}{77+4} = 0.9506$$

$$\text{Specificity} = \frac{TN}{TN+FP} = \frac{18}{18+0} = 1$$

$$\text{PPV} = \frac{TP}{TP+FP} = \frac{77}{77+0} = 1$$

$$\text{NPV} = \frac{TN}{TN+FN} = \frac{18}{18+4} = 0.81$$

With the use of PSO in the SVM method, results with an accuracy level of approximately 96% were obtained and the accuracy, specificity, ppv, and npv were evaluated.

Evaluation between Support Vector Machine (SVM) testing and Particle Swarm Optimization Application with SVM Method

Based on the obtained results, the software RapidMiner is used to evaluate support vector machines and particle swarm optimization. The following Table 3 lists the evaluations that can be performed by comparing the two methods of research:

Table 3. Results of the evaluation of the two test methods

Al-gortma	Acura-cy	AUC	Compar-ison
Support Vectore Machine (SVM)	94.89%	0.994 %	Accura-cy 2.89%
Support Vectore Machine (SVM) - PSO	96%	0.994 %	AUC 0%

The results of the study using the Support Vector Machine (SVM) method using Parti-cle Swarm Optimization for SVM method show that SVM has an ac-curacy of 94.89% and an AUC of 0.994%. On the other hand, SVM based on PSO indicates performance improve-ment with an accuracy of 96% and an AUC of 0.994%. The accuracy difference between the two methods is 2.89%, whereas SVM based on PSO indicates improvement. This indicates that PSO implementation in SVM can increase ac-curacy.

CONCLUSION

With the data from the electrical installation certification test results, the Support Vector Machine (SVM) method with a comparison of the application of PSO to the SVM method shows a differ-ence in performance between the two methods. The SVM test produces an ac-curacy value of 94.89% and an AUC of 0.994%. Then with the application of PSO with attribute selection, from the initial number of attributes of 7 predictor variables and after attribute selection 5 attributes are used (JK, KPK, KTL, KKB, KPM), because 2 attributes have values below 0.5, this makes the 2 attrib-utes have no effect. Produces an accuracy value of 96% and the same AUC of

0.994%. Thus, it can be concluded that the testing of electrical installation certification test result data with the PSO-based SVM method for attribute selection shows an increase in accuracy value of 2.89% compared to using only the SVM method. Although the AUC value remains the same in both methods, this increase in accuracy shows that the PSO-based SVM method is better in determining the results of the electrical installation certification operation feasibility test based on the attributes used, and these results are included in the excellent accuracy classification category. The next step in this research is that we will try ANN when combined with PSO to see whether it has better accuracy.

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