Analisis Tingkat Akurasi Penyebaran Penyakit TBC Menggunakan Algoritma Logistic Regression dan K-Nearest Neighbor di Kabupaten Muara Enim

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Dalam menyelesaikan Laporan Tugas Akhir ini penulis mendapatkan bantuan dan bimbingan dari berbagai pihak. Oleh karena itu, penulis mengucapkan terima kasih kepada:

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Jakarta, 28 Juni 2022
Penulis

DAFTAR ISI

NASKAH JURNAL

Analysis of Tuberculosis Disease Spreading Pattern in Muara Enim District using KNN Algorithm

Analysis of TB Disease Spreading Pattern using KNN Algorithm

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Tuberculosis (TB) is a type of infectious disease caused by Mycobacterium tuberculosis, which not only attacks the lungs, but can also attack the bones, intestines, or glands. During the Covid-19 pandemic, TB cases in Indonesia also increased. TB and Covid-19 had the similar symptoms such as cough, fever, and breathing difficulty, so that TB sufferers must be given serious treatment to avoid Covid-19. In predicting a disease, it is important for health workers to make decisions, thus it is necessary to do an early diagnosis in order to reduce the transmission of TB in the community. There are many algorithm methods used in conducting data analysis, for this study the authors use K-Nearest Neighbor (K-NN) algorithm and Logistic Regression as comparison. Experimental results using available dataset collected from health centers in Muara Enim District of South Sumatra Province show that the K-NN algorithm provides the best accuracy of 89% on dataset with training to testing data ratio of 80%:20%, while the Logistic Regression provides the best accuracy of 96% on 70%:30% ratio. The analysis mechanism discussed in this paper may be considered as tool for the authority to predict and take necessary actions to prevent the TB spreading.

CCS CONCEPTS • Computing methodologies • Machine learning

Additional Keywords and Phrases: TB, Logistic Regression, K-Nearest Neighbor

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1 INTRODUCTION

Tuberculosis (TB) is a type of infectious disease caused by Mycobacterium tuberculosis, which not only attacks the lungs, but can also attack the bones, intestines, or glands. World Health Organization (WHO) has declared TB as a global emergency. TB is still a threat to countries in the world and needs to be eradicated optimally. Symptoms such as fever, cough, chest pain and shortness of breath are things that cause TB disease. In Indonesia, TB is ranked as the second dangerous infectious disease with 845, 000 cases and 98,000 deaths. The Indonesian government attempts to reduce the number of TB sufferers by 2030 by means of prevention, diagnosis, treatment, and providing health services for all TB sufferers. During the pandemic, TB cases in Indonesia increased, TB and Covid-19 had the same symptoms such as cough, fever, and difficulty breathing. So that TB sufferers must be given serious treatment to avoid Covid-19 [1].

Because this disease is contagious, a system is needed to predict the spread of TB cases, one of which is making predictions using data science techniques. In predicting a disease, it is important for health workers to make decisions, thus it is necessary to perform an early diagnosis based on appearing symptoms, in order to

reduce the transmission of TB in the community. There are many algorithms used in conducting data analysis. The K-Nearest Neighbor (K-NN) algorithm is one of the popular methods in data classification. This algorithm is very suitable to be used because it is easy to implement in diagnosing a disease, K-NN is usually applied in data classification based on the value of K, i.e.: the value of the nearest neighbor [5]. Because it is only seen from the value of the nearest neighbor, this algorithm is called lazy learning [6]. Besides, K-NN is also effective if implemented on large training data [7]. Logistic Regression Algorithm is the most famous machine learning algorithm after Linear Regression. The algorithm is also used for classification tasks [8and commonly used in the approach to make a predictive model of an event [9].

A previous study on warts disease analysis using K-NN obtained an accuracy of 90.90% [2]. Another study on heart disease analysis using the K-NN algorithm provided an accuracy of 96.66% [3]. A research work using the Logistic Regression algorithm on cardiovascular disease analysis obtained an accuracy of 87.10% [4].

Based on previous research works mentioned above, the authors are interested in choosing the K-NN algorithm for this study and use the Logistic Regression as comparison to analyze and predict the spread of TB cases.

The rest of the paper is arranged as follows. Section 2 discusses the proposed method along with the dataset for the experiment. Section 3 presents the experimental results and discussion, and lastly, Section 4 provides the conclusion and future works.

2 RESEARCH METHOD

Figure 1 depicts the work flow of the proposed research method. The first step is to construct TB disease spreading dataset. The raw data is obtained from the Unit of Health, Muara Enim District. Then the raw data was cleaned through a data preprocessing. The clean dataset are then splitted into training and testing dataset. Next step is implementation of the KNN and Logistic Regression algorithms followed by experimentation and validation using K-fold Cross Validation. The last step is to report the experimentation results in terms of accuracy and other performance metrics.

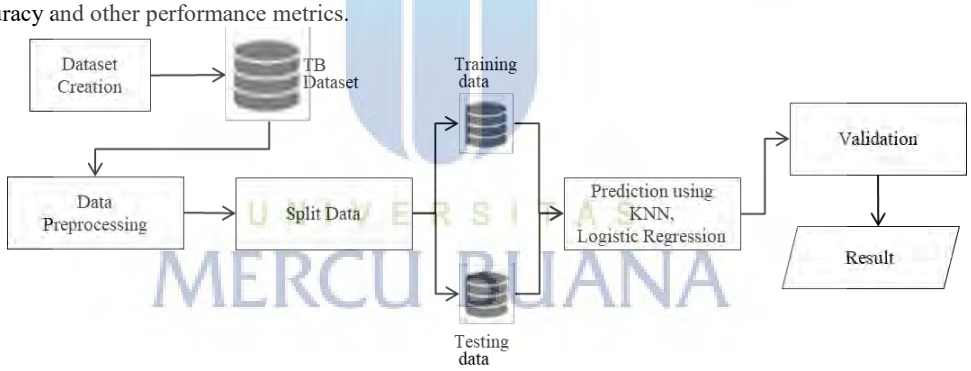


Figure 1. The proposed research method

2.1 Dataset

The data are collected from 40 healthcare centers in the district. After data cleaning process, the dataset consists of 640 rows. Each row has 9 attributes, i.e.: Health center name, category, age, gender, type of patient (new patient, relapse patient, patient with TB disease history other than relapse, patient without treatment history), and number of patients.

2.2 Data Split

Types of data in the dataset are already in numeric format, thus no data conversion is performed during the preprocessing. The preprocessing data involves normalization and completing the missing data only.

Next is dataset description process and determine the dependent variable and independent variables. The dataset is split with three scenarios for the ratio of training and testing data as follows: 90%:10%, 80%:20% and 70%:30%. The dataset description is shown in Figure 2 to Figure 6. The figures show the increase trend of TB disease sufferers.

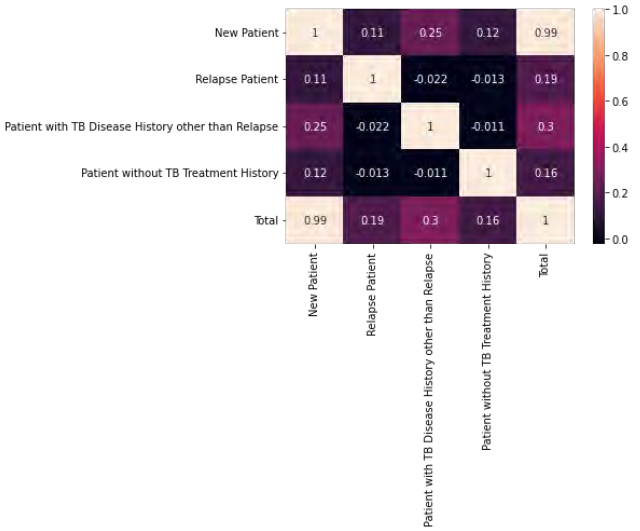


Figure 2. Correlation among features/attributes

Figure 2 sows the correlation test among variables, generated by Heatmap.

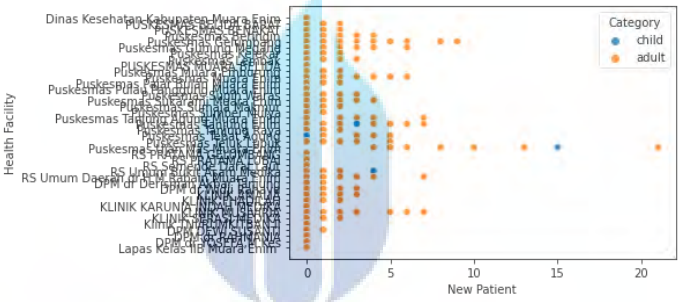


Figure 3. Scatterplot of New Patient

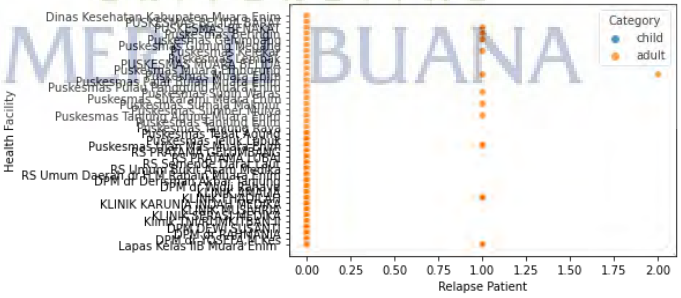


Figure 4. Scatterplot of Relapse Patient

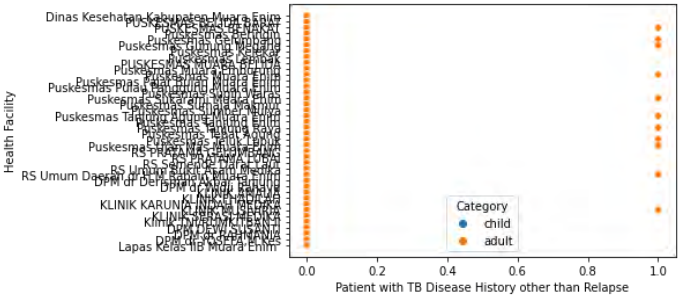


Figure 5. Scatterplot of patient with TB disease history other than relapse

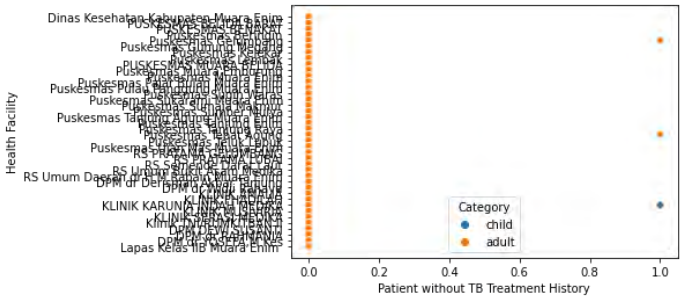


Figure 6. Scatterplot of patient without TB treatment history

2.3 K-Nearest Neighbor

K-Nearest Neighbor (KNN) is a type of classification algorithm by determining the value of the nearest neighbor. The KNN algorithm was chosen because it has advantages such as easy to understand and implement, very fast and effective training if the training data is large enough. One of the weaknesses of this algorithm is that it is necessary to determine the value of the K parameter, namely the number of nearest neighbors. To use this algorithm, it is necessary to initialize the K parameter [12], in this study the K value used is K = 1 to K = 9, and obtain the K value with the best accuracy. Euclidean distance is the most commonly used distance calculation in the KNN algorithm (1).

$$d(x,y) = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2} \quad (1)$$

x_i = sample data
y_i = testing data
i = variable data
d(x, y) =dissimilarity/distance
n = data dimension

2.4 Logistic Regression

Logistic Regression is a classification algorithm to find the relationship between discrete/continuous features (input) with the probability of certain discrete output results and is part of the regression analysis used when the dependent variable (response) is a dichotomous variable that has a value of 0 or 1 [10]. The result variable is dichotomous which has two possibilities, yes or no, this algorithm can be used to detect TB disease. The equation for Logistic Regression is shown in (2) [16].

$$Ln\left(\frac{p}{1-p}\right) = B_0 + B_1X \quad (2)$$

B_0 = constant
B_1 = coefficient of each variable

The p value or probability (Y =1) can be determined by (3).

$$p = \frac{e^{(B_0 + B_1X)}}{(1 + e^{(B_0 + B_1X)})} \quad (3)$$

2.5 k-Fold Cross Validation

k-Fold Cross Validation is one method that is commonly used in model selection [13]. k-Fold Cross Validation increases the flexibility of the selected model and obtains maximum accuracy results [14]. Its function is to divide the data sample randomly and group the data as many as the k value. In machine learning, the k value that is often used is 10 [15].

3 Result And Discussion

As mentioned in Section 2.1, the experiments use three data split scenarios for training data and testing data. The experiments are carried out on a computer with the following specifications. Processor 11th Gen Intel(R)

Core(TM) i5-1135G7 @ 2.40GHz, 8 GB RAM, running Windows 11 operating system and Python language programming on *Google Colab* platform.

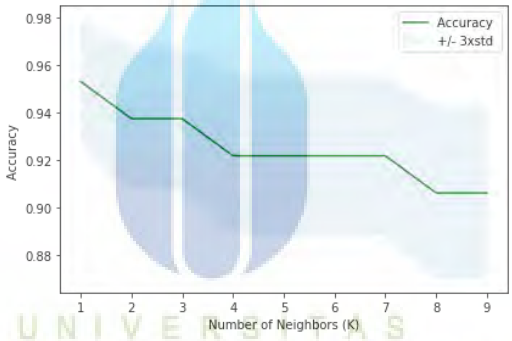
3.1 K-Nearest Neighbor Implementation

The KNN algorithm is implemented using Skicit learn library. Table 2 shows the accuracy for K=4 on training data and testing data. The testing with the value of K = 4 is considered based on the number and size of the data dimensions. The more data used, the lower the value of K. The larger the data dimension the higher the value of K chosen.

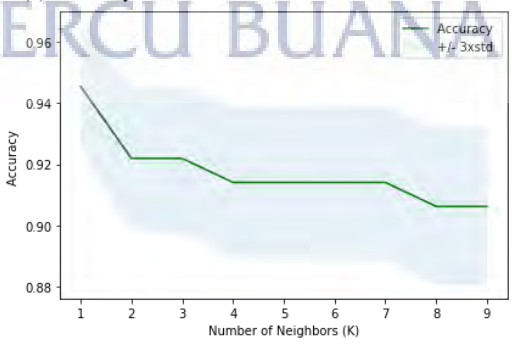
Table 1. Accuracy for K=4

Scenario	Training	Testing
90%:10%	0.97	0.92
80%:20%	0.97	0.91
70%:30%	0.97	0.93

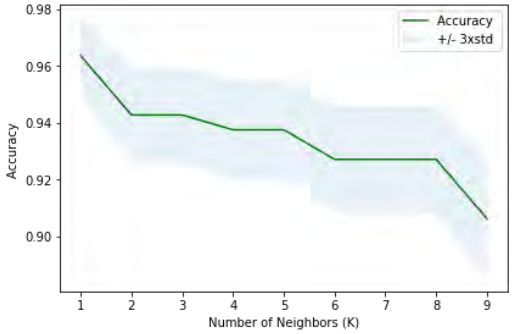
Next, performing experiments for variant values of K (from K=1 to K=9) for each dataset ratio scenario. Accuracy for variant values of K on the testing dataset is shown in Figure 7. The best accuracy for 90% to 10% ratio of dataset is achieved for K=1, i.e.: 0.95 (see Figure 7.a). The best accuracy for 80% to 20% ratio of dataset is also achieved for K=1, i.e.: 0.94 (see Figure 7.b). 70% to 30% ratio of dataset is also achieved for K=1, i.e.: 0.96 (see Figure 7.c). Table 2 summarizes the best accuracy during the testing for each algorithm and for each scenario.



(a) Accuracy for variant values of K on 90%:10% ratio



(b) Accuracy for variant values of K on 80%:20% ratio



(c) Accuracy for variant values of K on 70%:30% ratio

Figure 7. Accuracy for different values of K

Table 2. Accuracy Result of KNN Algorithm

Dataset ratio	The best value of K	Training Accuracy	Testing Accuracy
90%:10%	K=1	1.0	0.95
80%:20%	K=1	1.0	0.94
70%:30%	K=1	1.0	0.96

3.2 Logistic Regression Implementation

Experimental results during testing for Logistic Regression algorithm are shown in Table 3.

Table 3. Accuracy Result of Logistic Regression Algorithm

Dataset ratio	The best value of K	Training Accuracy	Testing Accuracy
90%:10%	K=1	1.0	82.81
80%:20%	K=1	1.0	89.84
70%:30%	K=1	1.0	77.08

3.3 k-Fold Cross Validation Result

The KNN and Logistic Regression algorithms are validated using 10-Fold cross validation method with random state 1 and the results are shown in Table 4. Average score for K-nearest Neighbor and Logistic Regression algorithm is 0.98 and 0.82, respectively.

Tabel 4 Accuracy comparison

Dataset ratio	Logistic Regressiom	K-Nearest Neighbor
90%:10%	82%	95%
80%:20%	89%	94%
70%:30%	77%	96%

From Table 4, we may conclude that Logistic Regression algorithm achieves the best accuracy level of 89% using the 80%:20% dataset ratio. Whereas, K-Nearest Neighbor algorithm achieves the best accuracy level of 96% using the 70%:30% dataset ratio.

4 CONCLUSION

Tuberculosis and Covid-19 have almost similar symptoms, so it is necessary to pay attention to avoid TB patients from Covid-19 infection. Experimental results showed that the accuracy of prediction analysis of Tuberculosis disease spreading pattern in Muara Enim District using KNN algorithm is higher than Logistic Regression. The best accuracy value using Logistic Regression algorithm is 89% while the best accuracy using K-Nearest Neighbor algorithm is 96%.This research provides useful insights regarding the spread of TB during the Covid-19 pandemic and the use of K-Nearest Neighbor algorithm as a reference for further research.

This research only compares the KNN algorithm with Logistic Regression and does not consider existing works, as we use specific dataset. Thus, the authors consider other techniques such as Artificial Neural Network, Support Vector Machine, and Fuzzy inference to be implemented to analyze the dataset.

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KERTAS KERJA

Ringkasan

Kertas kerja ini merupakan material kelengkapan artikel jurnal dengan judul "Analisis Tingkat Akurasi Penyebaran Penyakit TBC Menggunakan Algoritma Logistic Regression dan K-Nearest Neighbor di Kabupaten Muara Enim". Kertas kerja berisi semua material hasil penelitan Tugas Akhir yang tidak dimuat/atau disertakan di artikel jurnal. Di dalam kertas kerja ini disajikan: literature review, dataset yang digunakan, source code, dan hasil eksperimen secara keseluruhan.

Bagian I merupakan literature review dari hasil review jurnal yang terkait dalam penelitian ini. Bagian II merupakan source code yang digunakan dalam penelitian. Bagian III merupakan bagian yang menjelaskan dataset yang digunakan. Bagian IV merupakan tahapan eksperimen yang dilakukan dalam penelitian ini. Bagian V merupakan bagian yang menjelaskan hasil dari keseluruhan ekperimen.