JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. VIII No 3, Agustus 2022, hlm. 271 - 278 ISSN 2550-0201 (Online)
DOI: https://doi.org/10.33330/jurteksi.v8i3.1482
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

COMPARISON OF MULTILAYER PERCEPTRON'S ACTIVATION AND OPTIMIZATION FUNCTIONS IN CLASSIFICATION OF COVID-19 PATIENTS

Doughlas Pardede[1*], Ichsan Firmansyah[1], Meli Handayani[1], Meisarah Riandini[1], Rika Rosnelly[1]
[1]Ilmu Komputer, Universitas Potensi Utama
email: *doug.pardede@gmail.com

Abstract: Patient's symptoms could be used as features in Covid-19 classification. Using *multi layer perceptron*, the classification uses data set that contains patient's diagnosis which has Covid-19 symptoms dan processes the data set to see if the patient is Covid-19 positive or not. This paper compare four activation function such as identity, logistic, ReLu and tanh and combined them with optimizer such as L-BFGS-B, SGD and Adam. Using 5-fold and 10-fold cross validation technique to get the accuracy, F1, precision and recall values, the result that we get is that logistic function with L-BFGS-B optimizer and ReLu function with L-BFGS-B optimizer are the best combinations. The logistic function with SGD optimizer, ReLu function with Adam optimizer and tanh function with Adam optimizer are the worst combinations according to their accuration values. The logistic function with SGD optimizer is the worst combination according to its F1 value. The logistic function with SGD optimizer and tanh function with L-BFGS-B optimizer are the worst combinations according to their precision values. The logistic function with SGD optimizer, ReLu function with Adam optimizer and tanh function with Adam optimizer are the worst combinations according to their recall values.

Keywords: activation function, covid-19; multi layer perceptron; optimizer algorithm

Abstrak: Diagnosa gejala yang dialami pasien dapat digunakan sebagai fitur dalam klasifikasi penderita Covid-19. Dengan *multi layer perceptron*, klasifikasi dilakukan menggunakan data set yang berisi hasil diagnosa pasien yang memiliki gejala Covid-19 dan selanjutnya diolah untuk melihat apakah memang pasien tersebut menderita Covid-19 atau tidak. Penelitian ini membandingkan fungsi aktivasi *identity*, *logistic*, ReLu dan *tanh* yang dikombinasikan dengan algoritma optimasi L-BFGS-B, SGD dan Adam. Hasil evaluasi *cross validation* menggunakan 5-*fold* dan 10-*fold* digunakan sebagai dasar menentukan kombinasi yang terbaik dan terburuk, dengan hasil yang menunjukkan bahwa kombinasi fungsi logistic dengan optimasi L-BFGS-B dan fungsi ReLu dengan optimasi L-BFGS-B merupakan kombinasi terbaik. Kombinasi fungsi logisctic dengan optimasi SGD, fungsi ReLu dengan optimasi Adam dan fungsi tanh dengan optimasi Adam merupakan yang terburuk dari nilai *accuracy*. Kombinasi fungsi *logistic* dan optimasi SGD merupakan kombinasi terburuk dari nilai *F1*. Kombinasi fungsi *logistic* dengan optimasi SGD dan fungsi *tanh* dan optimasi L-BFGS-B merupakan yang terburuk dari nilai *precision*. Kombinasi fungsi *logisctic* dengan optimasi SGD, fungsi ReLu dengan optimasi Adam dan fungsi *tanh* dengan optimasi Adam merupakan kombinasi terburuk dari nilai *recall*.

Kata kunci: algoritma optimasi; covid-19; fungsi optimasi; multi layer perceptron

JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. VIII No 3, Agustus 2022, hlm. 271 - 278 ISSN 2550-0201 (Online)
DOI: https://doi.org/10.33330/jurteksi.v8i3.1482
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

INTRODUCTION

Coronavirus (Covid-19), a disease that attacks the human respiratory tract and causes a pandemic, was first discovered in November/December in the province of Wuhan, China [1]. The spread of the virus that entered Indonesia since March 2, 2020 has had an impact in terms of economy, social and psychology for the people of Indonesia. The most significant impact is seen from the economic perspective, where there has been a decline in Indonesia's economic growth of 5.32% since the second quarter of 2020[2].

The similarity of Covid-19's symptoms with influenza A and influenza B viruses makes it difficult to distinguish whether a patient has Covid-19 or not based on the symptoms they experience [3]. Therefore, it is important to develop a system that can filter the initial diagnosis of the patient's symptoms, to help determine whether the patient has Covid-19 or not.

Machine learning, especially artificial neural networks (ANN) can be used to classify whether a patient has Covid-19 or not, by looking at the data on the symptoms they suffer, such as fever, stuffy nose, headache, cough, sore throat, phlegm. , runny nose, frequent sneezing, fatigue, shortness of breath, nausea or vomiting, chills, stuffy throat, swollen tonsils, reduced sense of smell, and reduced sense of taste. From a collection of data that has been previously collected, these symptoms are used as categories in the MLP algorithm learning process so that the Yes or No classification of the patient suffers from Covid-19 is obtained [4].

As one of the algorithms that uses the ANN architecture, multilayer perceptron (MLP) has advantages in terms of its ability to adapt to the input data, is able to predict the relationship between the target class and the attributes of the object, and has a fairly good noise resistance. These advantages make MLP quite popular in classification studies [5].

Several studies that use the MLP algorithm in cases of Covid-19 disease, such as the classification of factors that contribute to the spread of Covid-19 [6], classification of high-risk places in the environment where Covid-19 patients are treated [7] and forecasting new Covid-19 cases based on previous case data [8], shows that MLP can be used for cases with a large number of features and data and is able to produce good accuracy.

The activation function is an imprtant part of MLP for optimizing the classification results, this is shown by research comparing the new universal activation function (UAF) with activation functions such as identity, rectified linear unit (ReLu), leaky ReLu, sigmoid, tanh, softplus, mish and exponential linear unit (ELU) for CIVAR-10 image data set classification. The precision value is above 0.8 for all activation functions except for the ReLu activation function (0.01), the highest precision value is achieved by the soft plus and UAF activation functions with a value of 0.902, the recall value is above 0.8 for all activation functions except the activation function. ReLu (0.1), the highest recall value was achieved by the softplus activation function and UAF with a value of 0.902, the F1 value was above 0.8 for all activation functions except the ReLu activation function (0.018) [9].

The optimization function is also an important part of MLP in optimizing its classification accuracy, this is shown by research comparing the combination of the ReLu activation function with the adaptive moment estimation (Adam) op-

JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. VIII No 3, Agustus 2022, hlm. 271 - 278 ISSN 2550-0201 (Online)
DOI: https://doi.org/10.33330/jurteksi.v8i3.1482
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

timization function, stochastic gradient descent (SGD) and limited memory broyden fletcher goldfarb shanno bound constraint (LBFGS-B) on the problem of classifying the eligibility of prospective husbands. The result of this study is that the highest accuracy is achieved by the combination of the ReLu activation function with Adam's optimization with an accuracy of 71.3%, precision of 72.8% and recall of 71.3% [10].

In classifying data using MLP, the selection of a combination of activation functions and optimization algorithms is very important to consider in order to obtain good classification accuracy results. This is shown by a study comparing the combination of MLP optimization algorithms between stochastic gradient descent (SGD), Adam and LFBGS using the activation functions ReLu and tanh. The results obtained are, for the number of dimensions of principal component feature analysis (PCA) 1 to 30, the highest accuracy value is achieved by the combination of ReLu activation function and Adam optimization as well as tanh activation function and Adam optimization with a value of 0.974 [11].

METHOD

This study compares the multilayer perceptron activation function in cases of classification of Covid-19 patients based on the symptoms suffered by patients using the Orange 3.30 application, with the model form as shown in Image 1. Orange 3.30 is used as a tool to process data sets, both training data and data. test in the field of machine learning. This application uses a widget to form a model that can be used for training, testing and evaluating the results of data set classification.

By using 100 neurons, the results of the classification using a combination of activation functions and the optimization algorithm were evaluated using cross validation with a number of folds of 5 and 10 to see the values of accuracy, precision, F1 and recall. The average values of accuracy, precision, F1 and recall are then analyzed to see which combination of activation functions and optimization algorithms is the best and worst in the case of the classification of Covid-19 sufferers.

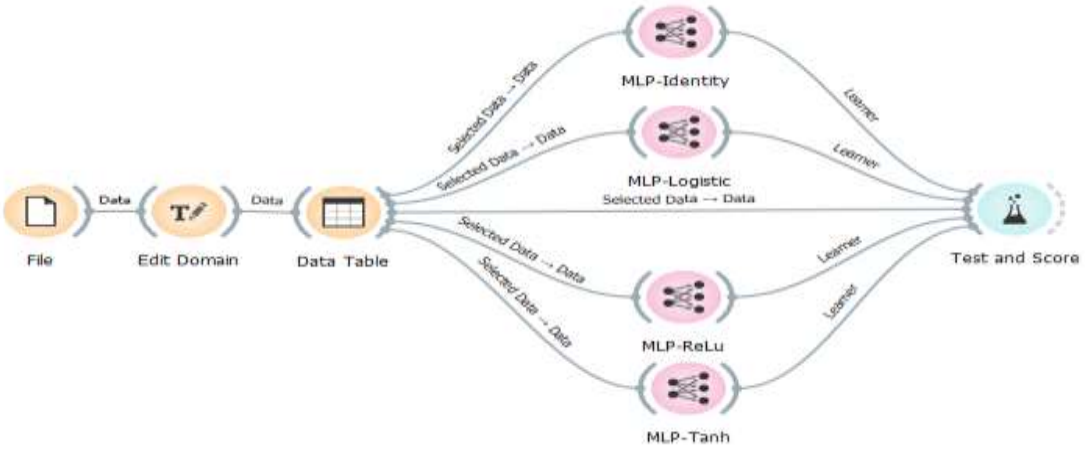


Image 1. Classification Model

The File Widget is used to read data sets in XLSX format. The Edit Do-

JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. VIII No 3, Agustus 2022, hlm. 271 - 278 ISSN 2550-0201 (Online)
DOI: https://doi.org/10.33330/jurteksi.v8i3.1482
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

main widget is used to normalize the data set, where the value of yes is changed to a value of 1 and the value of no is changed to a value of 0. The Data Table Widget is used to display the normalization results in tabular form, where the data is grouped in tabular form based on 13 features and 1 target on datasets.

The MLP-Identity widget is used as a learner to process data using MLP with the identity activation function. MLP-Logistic widget is used as a learner to process data using MLP with logistic activation function. The MLP-ReLu widget is used as a learner to process data using MLP with the ReLu activation function. The MLP-Tanh widget is used as a learner to process data using MLP with the tanh activation function. Classification parameters such as the number of neurons in the hidden layer are used, the optimizer function and the maximum iterations for each widget MLP-Identity, MLP-Logistic, MLP-ReLu and MLP-Tanh.

The Test and Score widget is used to evaluate the classification of each learner which contains ac-curacy, F1, precision and recall values based on the selected number of folds..

The data set obtained from the kaggle.com site is 5434 patient data with Covid-19 symptoms as of May 2020 with 13 features and 1 target, where each data has a Yes or No value for each feature and target [12]. The data set is normalized, by changing the data with a value of Yes to data with a value of 1 and data with a value of No into data with a value of 0, to facilitate the process of calculating the values of accuray, F1, precision and recall because the data set is transformed into binary data. Table 1 shows a sample of 10 data from the normalized data set.

The classification process using the MLP algorithm uses classification parameters such as the number of neurons in the hidden layer, the number of folds in cross validation, activation functions and optimization algorithms, as shown in Table 2.

Table 1. Data Set Normalization Sample

B	F	DC	ST	RN	A	CLD	H	HD	D	HT	Ft	G	C19
1	1	1	1	1	0	0	0	0	1	1	1	1	1
1	1	1	1	0	1	1	1	0	0	0	1	0	1
1	1	1	1	1	1	1	1	0	1	0	1	1	1
1	1	1	0	0	1	0	0	1	1	0	0	0	1
1	1	1	1	1	0	1	1	1	1	1	0	1	1
0	0	0	0	1	0	0	1	0	0	0	1	0	0
0	0	0	0	1	0	1	0	0	0	1	1	0	0
0	0	0	0	1	0	0	1	1	0	1	1	0	0
0	0	0	0	1	1	0	1	1	1	0	0	0	0
0	0	0	0	1	0	0	1	1	1	0	1	1	0

JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. VIII No 3, Agustus 2022, hlm. 271 - 278 ISSN 2550-0201 (Online)
DOI: https://doi.org/10.33330/jurteksi.v8i3.1482
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

Table 2. Classification Parameters

Parameter	Nilai
Jumlah *neuron* dalam *hidden layer*	100
k-*fold cross validation*	5 dan 10
Fungsi Aktivasi	Identity, Logistic, ReLu dan Tanh
Algoritma optimasi	L-BFGS-B, SGD dan Adam

BP = *Breathing Problem*, F = *Fever*, DC = *Dry Cough*, ST = *Sore Throat*, A = *Asthma*, CLD = *Chronic Lung Disease*, H = *Headache*, HD = *Heart Disease*, D = *Diabetes*, HT = *Hyper Tension*, Ft = *Fatigue*, G = *Gastrointestinal*, C19 = *Covid-19*

The value of classification accuracy, F1, precision and recall is calculated using equation (1) to equation (3) [13]:

$$\text{CA} = \frac{TP+TN}{TP+TN+FP+FN} \quad (1)$$

$$\text{P} = \frac{TP}{TP+FP} \quad (2)$$

$$R = \frac{TP}{TP+FN} \quad (3)$$

$$\text{F1} = 2 . \frac{\text{P} . R}{P+R} \quad (4)$$

Where:
TP = *True Positive*, TN = *True Negative*, FP = *False Positive*, FN = *False Negative*, CA = *Classification Accuracy*.

RESULT AND DISCUSSION

Each classification parameter in Table 2 is entered into the MLP model in Figure 1 with a maximum number of epochs of 100.

Using MLP-Identity, MLP-Logistic, MLP-ReLu and MLP-Tanh learners, the resulting classification of Covid-19 sufferers is then evaluated using cross validation to obtain accuracy, F1, precision and recall values.

Image 2 and Image 3 show the evaluation of the classification using fold values of 5 and 10 for the respective combinations of activation functions and optimization algorithms L-BFGS-B, SGD and Adam. The results of this cross validation are then calculated the average value based on the fold value used. This average value is used to compare the accuracy, F1, precision and recall of each combination of activation functions and optimization algorithms.

Evaluation Results

Model	CA	F1	Precision	Recall
MLP-Identity	0.916	0.913	0.914	0.916
MLP-Logistic	0.980	0.981	0.981	0.980
MLP-ReLu	0.980	0.981	0.981	0.980
MLP-Tanh	0.978	0.979	0.979	0.978

L-BFGS-B Optimizer

Evaluation Results

Model	CA	F1	Precision	Recall
MLP-Identity	0.916	0.913	0.914	0.916
MLP-Logistic	0.905	0.896	0.905	0.905
MLP-ReLu	0.930	0.926	0.929	0.930
MLP-Tanh	0.926	0.922	0.924	0.926

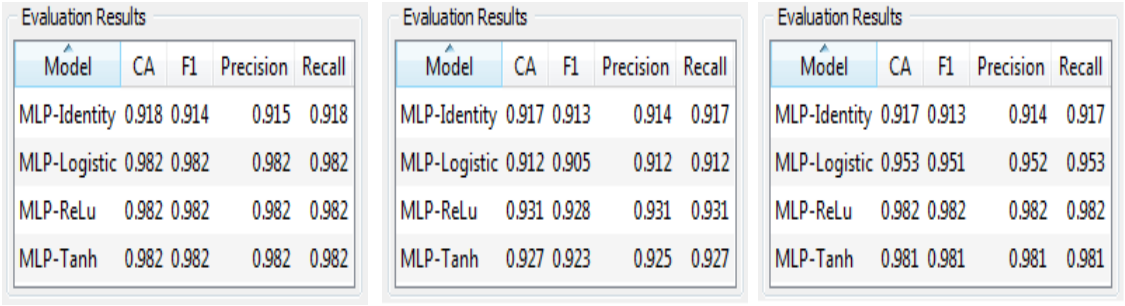
SGD Optimizer

Evaluation Results

Model	CA	F1	Precision	Recall
MLP-Identity	0.916	0.912	0.914	0.916
MLP-Logistic	0.946	0.944	0.945	0.946
MLP-ReLu	0.979	0.980	0.980	0.979
MLP-Tanh	0.980	0.981	0.981	0.980

Adam Optimizer

Image 2. 5-Fold Cross Validation Result



L-BFGS-B Optimizer SGD Optimizer Adam Optimizer

Image 3. 10-Fold Cross Validation Result

Table 3. Cross Validation Average Comparison

Activation Function	Optimizer	Accuracy	F1	Precision	Recall
Identity	LBFGSB	**0.917**	**0.9135**	**0.9145**	**0.917**
	SGD	0.9165	0.913	0.914	0.9165
	Adam	0.9165	0.9125	0.914	0.9165
Logistic	LBFGSB	**0.981**	**0.9815**	**0.9815**	**0.981**
	SGD	0.9085	0.9005	0.9085	0.9085
	Adam	0.9495	0.9475	0.9485	0.9495
ReLu	LBFGSB	**0.981**	**0.9815**	**0.9815**	**0.981**
	SGD	0.9305	0.927	0.93	0.9305
	Adam	0.9805	0.981	0.981	0.9805
Tanh	LBFGSB	0.98	0.9805	0.9805	0.98
	SGD	0.9265	0.9225	0.9245	0.9265
	Adam	**0.9805**	**0.981**	**0.981**	**0.9805**

Table 3 shows the cross-validation comparison of the combination of each activation function and optimization algorithm.

The highest accuracy value was achieved by a combination of logistics activation function with L-BFGS-B optimization and ReLu activation function with L-BFGS-B optimization with a value of 0.981, while the lowest accuracy value was achieved by a combination of logistic activation function with SGD optimization. ReLu activation function with Adam optimization and tanh activation function with Adam optimization with a value of 0.9805.

The highest F1 value was achieved by a combination of logistic activation function with L-BFGS-B optimization and ReLu activation function with L-BFGS-B optimization with a value of 0.9815, while the lowest F1 value was achieved by a combination of logistic activation function and SGD opti-

mization with a value of 0.9005.

The highest precision value was achieved by a combination of logistic activation function with optimization of L-BFGS-B and ReLu activation function with optimization of L-BFGS-B with a value of 0.9815, while the lowest precision value was achieved by a combination of logistic activation function with optimization of SGD and tanh activation function. and optimization of L-BFGS-B with a value of 0.9085.

The highest recall value was achieved by a combination of logistic activation function with optimization of L-BFGS-B and ReLu activation function with optimization of L-BFGS-B with a value of 0.981, while the lowest recall value was achieved by a combination of logistic activation function with optimization of SGD, ReLu activation function with Adam optimization and tanh activation function with Adam optimization with a value of 0.9805.

CONCLUSION

From the results of the evaluation of the classification of Covid-19 patients using a combination of identity, logistic, ReLu and tanh activation functions with the optimization algorithm L-BFGS-B, SGD and Adam, it was concluded that to produce the best performance from the classification results of the MLP algorithm, L-BFGS-B is the optimization function that is most suitable to be combined with identity, logistics and ReLu activation functions; while Adam is the most suitable optimization function to be combined with the Tanh activation function. In the MLP architecture, it is best to avoid using the combination of Logistic, ReLu and Tanh activation functions with the SGD optimization function, as well as the combination of the identity activation function with the Adam optimization function, because it will produce the lowest classification performance.

BIBLIOGRAPHY

[1] Z. Car, S. Baressi Šegota, N. Anđelić, I. Lorencin, and V. Mrzljak, "Modeling the Spread of COVID-19 Infection Using a Multilayer Perceptron," *Comput. Math. Methods Med.*, vol. 2020, 2020, doi: 10.1155/2020/5714714.

[2] D. D. Romani, D. Nasution, A. Syahputra, and ..., "Artificial Neural Network Model In Forecasting Post-Covid-19 Aviation Business Development Using Multi Layer Perceptron (MLP)," *Budapest Int. Res. Critics Insitute-Journal*, vol. 4, no. 4, pp. 13189–13199, 2021, [Online]. Available: http://bircu-journal.com/index.php/birci/article/view/3384.

[3] M. M. Ahsan, T. E. Alam, T. Trafalis, and P. Huebner, "Deep MLP-CNN model using mixed-data to distinguish between COVID-19 and Non-COVID-19 patients," *Symmetry (Basel).*, vol. 12, no. 9, 2020, doi: 10.3390/sym12091526.

[4] F. Mohammadi *et al.*, "Artificial neural network and logistic regression modelling to characterize COVID-19 infected patients in local areas of Iran,"

Biomed. J., vol. 44, no. 3, pp. 304–316, 2021, doi: 10.1016/j.bj.2021.02.006.

[5] D. Pardede, B. H. Hayadi, and Iskandar, "Kajian literatur multi layer perceptron: seberapa baik performa algoritma ini," *J. ICT Apl. Syst.*, vol. 1, no. 1, pp. 23–35, 2022, [Online]. Available: https://e-jurnal.rokania.ac.id/index.php/jictas/article/view/127/84.

[6] S. Ibrahim, S. A. Kamaruddin, N. N. Abu Mangshor, and A. F. Ahmad Fadzil, "A study of Covid-19 spread and death contributing factors in America Using Multi-Layer Perception (MLP) and Radial Basis Function (RBF)," *Eur. J. Mol. Clin. Med.*, vol. 8, no. 2, pp. 144–158, 2021, [Online]. Available: https://www.embase.com/search/results?subaction=viewrecord&id=L2011094292&from=export.

[7] N. N. Samany, A. Toomanian, A. Maher, K. Hanani, and A. R. Zali, "The most places at risk surrounding the COVID-19 treatment hospitals in an urban environment- case study: Tehran city," *Land use policy*, vol. 109, no. 1, p. 105725, 2021, doi: 10.1016/j.landusepol.2021.10572.

[8] R. P. Shetty and P. S. Pai, "Forecasting of COVID 19 Cases in Karnataka State using Artificial Neural Network (ANN)," *J. Inst. Eng. Ser. B*, vol. 102, no. 6, pp. 1201–1211, Dec. 2021, doi: 10.1007/s40031-021-00623-4.

[9] B. Yuen, M. T. Hoang, X. Dong, and T. Lu, "Universal activation function for machine learning," *Sci. Rep.*, vol. 11, no. 1, pp. 1–12, 2021, doi: 10.1038/s41598-021-96723-8.

[10] M. Handayani, M. Riandini, and Z. Situmorang, "Perbandingan Fungsi Optimasi Neural Network Dalam Klasifikasi Kelayakan Calon Suami," *J. Inform.*, vol. 9, no. 1, pp. 78–84, 2022, doi: https://doi.org/10.31294/inf.v9i1.12318.

[11] M. S. Wibawa and I. M. D. Maysanjaya, "Multi Layer Perceptron Dan Principal Component Analysis Untuk Diagnosa Kanker Payudara," *J. Nas. Pendidik. Tek. Inform.*, vol. 7, no. 1, p. 90, 2018, doi: 10.23887/janapati.v7i1.12909.

[12] H. Harikrishnan, "Symptoms and COVID Presence (May 2020 data)," 2020. https://www.kaggle.com/datasets/hemanthhari/symptoms-and-covid-presence.

[13] K. F. Margolang, M. M. Siregar, S. Riyadi, and Z. Situmorang, "Analisa Distance Metric Algoritma K-Nearest Neighbor Pada Klasifikasi Kredit Macet," *J. Inf. Syst. Res.*, vol. 3, no. 2, pp. 118–124, 2022, doi: 10.47065/josh.v3i2.1262.