

## Comparison of Conventional Machine Learning and Deep Neural Network Algorithms in the Prediction of Monkey-Pox

Cucu Ika Agustyaningrum<sup>-1\*</sup>, Rizka Dahlia<sup>-2</sup>, Omar Pahlevi<sup>-3</sup>

Fakultas Teknik dan Informatika<sup>1,2,3</sup>  
Universitas Bina Sarana Informatika<sup>1\*</sup>,<sup>2,3</sup>  
cucu.cuk@bsi.ac.id<sup>1</sup>, rizka.rzl@bsi.ac.id<sup>2</sup>, omar.opi@bsi.ac.id<sup>3</sup>

(\*) Corresponding Author

### Abstract

Smallpox syndrome, or monkeypox, is an uncommon zoonotic viral infection brought on by the monkeypox virus, which belongs to the genus Orthopoxvirus and family Poxviridae. Injury-related mortality in primates ranges from 1 to 10%. Data mining is a method for analyzing data. Deep neural networks and traditional machine learning methods are used in data analysis. The Python programming language is used during the comparison procedure of this research algorithm to generate values for accuracy, f1 score, precision, recall, ROC, and AUC. The test results demonstrate that using sigmoid activation function parameters, the deep neural network algorithm's accuracy is 70.08%, F1 score is 79.18%, precision is 68.59%, recall is 62.65%, and AUC is 62.65%. Compared to conventional machine learning algorithms, the adagrad optimizer has a higher value with a learning rate of 0.01 and 0.2 dropouts. The conventional machine learning model algorithm has the best xgboost, F1 score, precision, recall, and AUC scores compared to other approaches: 64.40%, 64.45%, and 78.14%. According to these numbers, the average fairness disparity between deep neural network algorithms and traditional machine learning is 5.68%, F1 score is 13.79%, precision is 4.14%, recall is 1.75%, and AUC is 1.75%.

Keywords: Conventional Machine Learning; Data Mining; Deep Neural Network; Monkeypox

### Abstrak

Cacar monyet, juga dikenal sebagai cacar singe, atau simian orthopoxvirus, adalah infeksi virus zoonosis langka yang disebabkan oleh virus cacar monyet, genus orthopoxvirus dari keluarga Poxviridae. Tingkat kematian cacar monyet bervariasi dari 1 hingga 10,4%. Pengolahan data dapat dilakukan menggunakan data mining. Proses untuk menilai data menggunakan dua algoritma yaitu algoritma conventional machine learning dan deep neural network. Proses perbandingan algoritma penelitian ini menggunakan bahasa pemrograman python dengan menghasilkan nilai akurasi, f1-score, precision, recall, ROC dan AUC. Hasil pengujian terdapat nilai akurasi algoritma deep neural network sebesar 70,08%, F1 score 79,18%, precision 68,59%, recall 62,65% dan AUC 62,65% dengan parameter activation function sigmoid, optimizer adagrad dengan learning rate 0,01 dan dropout 0,2 memiliki nilai yang lebih tinggi daripada menggunakan algoritma conventional machine learning. Pada algoritma conventional machine learning model xgboost sebesar 64,40%, F1 score 64,40%, precision 64,45%, recall 64,40% dan AUC 78,14% paling tinggi dibandingkan metode yang lainnya. Dari nilai tersebut, dapat diketahui bahwa rata-rata perbedaan akurasi antara algoritma deep neural network dan conventional machine learning adalah 5,68%, F1 score 13,79%, precision 4,14%, recall 1,75% dan AUC 1,75%.

Kata kunci: Conventional Machine Learning; Data Mining; Deep Neural Network; Monkeypox

### INTRODUCTION

A different monkeypox virus shocked the globe while the COVID-19 pandemic attack continued (Rizk, Lippi, Henry, Forthal, & Rizk, 2022). Due to the similarities between the traits of this virus and those of smallpox and primates,

notably cynomolgus monkeys, it is known as monkey pox. Between 1960 and 1968, this case was first found by captive monkey colonies in the Netherlands and the US. However, even though many animals perished from smallpox at the time, there were no reports of monkeypox attacking people (Gessain, Nakoune, & Yazdanpanah, 2022).



Smallpox syndrome, also known as monkeypox, is an uncommon zoonotic viral infection brought on by the monkeypox virus, which belongs to the genus *Orthopoxvirus* and family *Poxviridae* (Koto-te-Nyiwa Ngbolua et al., 2020). Midway through 2022, specifically on May 21, 2022, this case began to flare up again. The lawsuit involves 13 nations, including Belgium, Canada, France, England, Australia, and Australia. Italy, Portugal, Spain, Sweden, the Netherlands, Germany, and the United States (Hraib, Jouni, Albitar, Alaidi, & Alshehabi, 2022). When a person comes into physical contact with exposed people, animals, or items, transmission may take place. In addition, animal bites, saliva specks, and mucus from the eyes, nostrils, or mouth can all contribute to the spread of the disease (Eid et al., 2022).

As the world is already impacted by the arrival of COVID-19 in 2020, the emergence of monkeypox in 2022, which is reported by many nations, demonstrates a new threat. The Zoonotic *Orthopoxvirus*, which is closely linked to cowpox and smallpox and is a member of the *Poxviridae* family, is the infectious agent that causes monkeypox (a member of the genus *Orthopoxvirus*). Spread mainly by monkeys and rodents, human-to-human transmission is also very prevalent. Fever, body aches, and exhaustion are some early signs of monkeypox infection, while red bumps on the skin are the long-term side effects (Ahsan et al., 2022). In people, the first signs of monkeypox include fever, chills, headaches, back and muscle discomfort, and fatigue (Yu et al., 2023). Swollen lymph nodes are among the additional signs distinguishing this form of monkeypox from smallpox (Shuvo, Roy, Dhawan, Chopra, & Emran, 2022).

Monkeypox has a mortality incidence that ranges from 1 to 10,4%. MPXV infection in humans can spread directly from infected animals to humans or indirectly through interaction with bodily fluids or respiratory droplets from infected individuals. Although monkeypox is a zoonotic illness, no known animal hosts exist. MPXV has twice been separated from animals in the wild (Berthet et al., 2021). The rise in reported incidents directly contributes to rising levels of tension and anxiety in the community.

As a consequence, we are seeing a lot of panicked reactions in both traditional and social media. The lack of precise solutions created to date is another aspect that adds to people's anxiety. There is currently no cure for those who have contracted the virus that causes monkeypox (Saha, Chakraborty, Bin Sulaiman, & Paul, 2023).

The Centers for Disease Control and Prevention state that no viable monkeypox virus (CDC) treatment exists. Due to a lack of medical supplies caused by increased patient volume, many of the nation's healthcare institutions and experts are experiencing difficulties (Koto-te-Nyiwa Ngbolua et al., 2020).

For those people who experience them, these symptoms can be categorized. Data mining is a method for analyzing data. Data from the Kaggle repository (Monkey-Pox Patients Dataset) with binary data characteristics were used in this research.

According to a related study, no one has ever used Python and a programming language to compare the two algorithms. Therefore, this research compares deep neural networks and conventional machine learning algorithms, the most accurate methods to forecast monkeypox outcomes using Python, producing the best results for researchers to see. a suitable monkeypox prediction.

This research is related to research conducted by (Gadekallu et al., 2020) with the research title Deep Neural Networks to Predict Diabetic Retinopathy. This research discusses applying a deep neural network model using the Gray Wolf Optimization (GWO) algorithm to classify the extracted features of the diabetic retinopathy data set. Based on the results of the DNN-PCA-GWO test, it is better than the support vector machine (SVM) algorithm, Naive Bayes Classifier, Decision Tree and XGBoost with 97.3% accuracy results.

Further research with the title An End-to-End Deep Learning Approach for Epileptic Seizure Prediction was conducted by (Xu, Yang, Zhao, Wu, & Sawan, 2020). This research discusses end-to-end deep learning using a convolutional neural network (CNN). One and two-dimensional kernels are adopted in early and late-stage convolution, and the top coalescence layer. Each. The proposed CNN model was evaluated on Kaggle intracranial and CHB-MIT scalp EEG data sets. At the end of the sensitivity level test, the false prediction rate and area under the receiver operating characteristic curve of 93.5%.

An Efficient Prediction System for Diabetes Disease Based on Deep Neural Networks was conducted by (Beghriche, Djerioui, Brik, Attallah, & Belhaouari, 2021). This article offers an effective medical decision system for diabetes prediction using Deep Neural Network (DNN). Based on the final test results, the DNN-based method performs well, with 99.75% accuracy and 99.66% F1 score.

## RESEARCH METHODS

A model created based on the research method, which included steps for the dataset, pre-processing, feature selection, smote, modeling, and model evaluation, was used in this study of monkeypox data. Data are first gathered for this study via the Kaggle Dataset website. Once the data is transformed into beginning data for pre-processing, Python selects the features. The data is balanced using the SMOTE method, and deep neural networks are tested using data cross-validation and more traditional machine learning algorithms.

There are two approaches to compare at this modeling stage: traditional machine learning and deep neural networks. The data is collected using the smote method before being entered into the modeling process. Smote is a data-sharing strategy that ensures the balance between individuals negatively or positively affected by monkeypox and unaffected by monkeypox. The data is cross-validated after the SMOT procedure, which evaluates the accuracy of the analytical results using the model validation method. Pre-processed data is cross-validated by dividing the classification procedure data into training and testing data (Panggabean, Buulolo, & Silalahi, 2020).

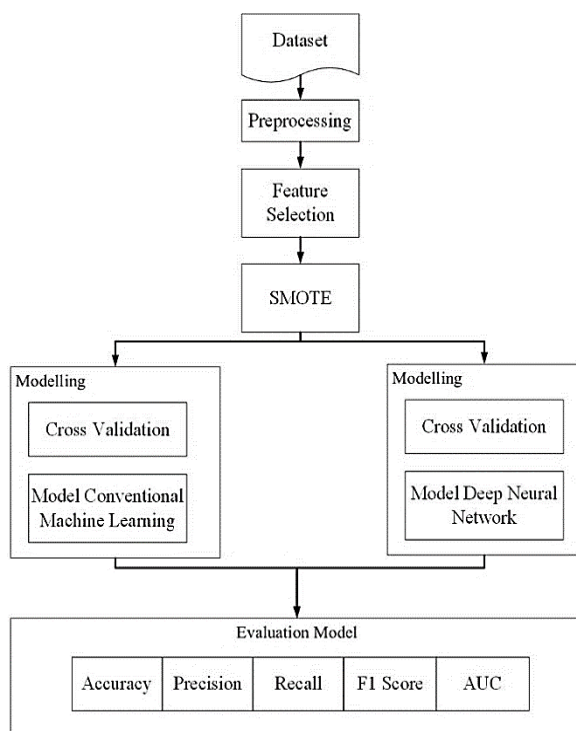


Figure 1 Research Stages

The Python data is then analyzed using deep neural networks and more traditional machine learning algorithms to determine which algorithm provides the best results for the data. This is done after data preparation, feature selection, smote modeling, and testing. The research stages are depicted in the diagram in Figure 1.

### Types of Research Methode of Collecting Data

Primary and secondary data are the two data sources that can be used in data-gathering procedures. Primary data is information obtained directly from the source, whereas secondary data is information obtained from researchers who have already conducted comparative research.

Researchers used secondary data in this investigation. The Monkey-Pox Patient Dataset retrieved from the Kaggle: Your Machine Learning dan Data Science Community contained 25000 records with 11 attributes and one attribute class, as shown in Table 1. These records included the following information:

Table 1 Description of the attributes of the monkeypox dataset :

No	Attribute Name	Data Type
1	Patient_ID	category and Numeric
2	Systemic Illness	category
3	Rectal Pain	category
4	Sore Throat	category
5	Penile Oedema	category
6	Oral Lesions	category
7	Solitary Lesion	category
8	Swollen Tonsils	category
9	HIV Infection	category
10	Sexually Transmitted Infection	category
11	MonkeyPox	category

### Procedure Application of Research Methods

Utilizing the monkeypox data set to apply research techniques Five steps are used in this application, namely:

#### 1. Data Set

The data utilized is secondary data, and it is based on data from UCI Machine Learning. It consists of 25,000 data with 11 attributes and 1 class to learn about monkeypox victims. These issues can be resolved, and the results are made more accessible, faster, and more accurate using classification systems with high degrees of prediction and accuracy values. This study

compared the Deep Neural Network algorithm and the Conventional Machine Learning method to produce findings with high prediction and accuracy.

## 2. Pre-processing

A total of 25,000 pieces of data were collected at this stage of the study, which would be analyzed before predictions were made to identify the data of monkeypox victims from information comparing exposure to monkeypox versus not having monkeypox. Selecting data and examining the attributes whose data type will be altered are the first steps in the data preparation stage.

The data cleaning procedure is carried out after the data selection phase. In this process, the vital thing to accomplish is to look for any missing values.

## 3. Feature Selection

It is used to identify the features that have the most significant impact on the data during the feature selection stage. Following the feature selection process, the data is class balanced using the SMOTE method to balance the class, and the data distribution employs cross-validation to simulate both deep neural network and conventional machine learning algorithms. The graphic below illustrates the factors influencing the outcome.

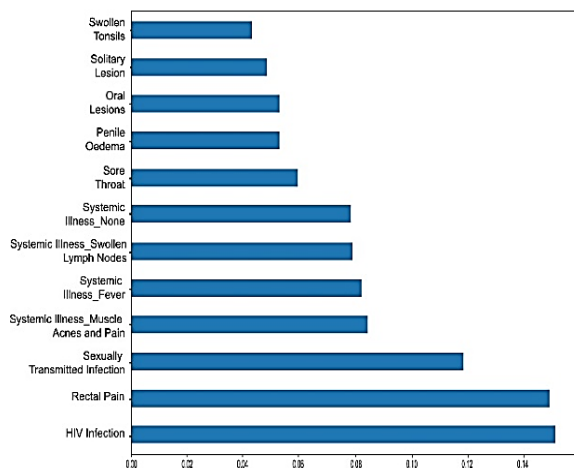


Figure 2 Feature importance: Elements that have an impact on the result

## 4. Modeling

The proposed algorithm performs the prediction process during the modeling or modeling step. The suggested algorithms are the deep neural network and the conventional machine learning algorithms. There are several

methods in the conventional machine learning algorithm, including the random forest, decision tree, ada boost, xg boost, and SVM methods, while the deep neural network algorithm uses three to eight layers of depth. The accuracy, f1 score, precision, recall, and AUC of monkeypox cases were evaluated using Python programming.

### a. Machine Learning

The automatic detection of basic patterns in data is known as machine learning. Through machine learning, computers can pick up knowledge from people. Without explicit programming, computers can learn to process material presented to them. Machine learning algorithms teach computers to analyze data (Agustyaningrum, Gata, Nurfalah, Radiyah, & Maulidah, 2020).

### b. Random Forest

Concept of Random Forest for producing a lot of correlated decision trees, where each decision tree acts as a collection of models. Every decision tree makes class predictions, with the maximum yield as the basis for the ultimate choice (Kabir, Ashraf, & Ajwad, 2019). The random forest classification method was developed using a decision tree technique that bases classification decisions on a random selection of attributes at each node. The decision tree's returned the most significant number of votes is used to classify data (Ratnawati & Sulistyaningrum, 2020).

Using a voting system (highest count) to combine independent classifiers (CARTs) from the same distribution random forest produces classification forecasts. Reduced correlation can lower the outcome of random forest prediction errors, a characteristic of random forest (As Sarofi, Irhamah, & Mukarromah, 2020). Random Forest Formula (Leonardo, Pratama, & Chrisnatalis, 2020):

$$Entropy(Y) = - \sum_{i=1}^n P(Y) \log^2 p(Y), \quad (1)$$

$$= Entropy(Y) - \sum_v \epsilon_{values}(a) \frac{|Y_v|}{|Y_a|} Entropy(Y_v). \quad (2)$$

### c. Decision Tree

The decision tree is one of data analysis's most widely used classification methods. A decision tree is a classification technique that uses a tree structure where each node represents an attribute, the branches represent the attribute's value, and the leaves represent the class. The decision tree's base node is the highest (Partogi & Pasaribu, 2022).



d. Ada Boost

A simulated learning algorithm called AdaBoost is frequently applied in boosting algorithms. The efficacy of classification can be enhanced by combining this improvement with other algorithms. The equation displays the Adaboost algorithm's computation (Gultom, 2020).

$$F(x) = \text{sign} \sum_{t=1}^T a_t h_t(x) \dots\dots\dots (3)$$

Information :

$h_t(x)$  = weak atau basic classifier

$\alpha_t$  = tingkat pembelajaran (learning rate)

$F(x)$  = final classifier

e. XG Boost

Extreme growth increase is referred to as XGBoost. An open-source project called Gradient Boosting uses the greedy function approach to create the gradient tree boosting machine learning system, which is effective, quick, and scalable for solving various learning problems. In supervised learning problems, XGBoost predicts the goal variable  $y_i$  using training data with multiple features  $x_i$  (Cucu Ika Agustyaningrum, Haris, Aryanti, & Misriati, 2021).

f. Support Vector Machine

Support Vector Machine (SVM) is an integrated (supervised) classification method that needs specific learning goals during training (Nurachim, 2019). A support vector machine algorithm is as follows (Zulfikar & Lukman, 2016).

$$\text{similarity} = \frac{\sum_{i=1}^n f(T_i, S_i)}{W_i} \dots\dots\dots (4)$$

Information:

Q: A new case

S: case in storage

n: the number of attributes

I: individual attribute between 1 and n

f: The tribute similarity function between case T and case S

W: the weight given to the i-th attribute

g. Deep Neural Network

In essence, deep learning applications have a multilayered profundity. Nodes that create a smaller network at each layer are used to obtain decisions. Starting with the input variables ( $X_1, X_2, X_3, \dots, X_n$ ) and the related weights, each layer with nodes will carry out calculations ( $w_1, w_2, w_3, \dots, w_n$ ) (Elujide et al., 2021).

Figure 3 shows that each input layer will be connected with weights. The following algorithm shows the formula that was used.

$$Z = f(x.b) = f(\sum_{i=1}^n x_i w_i + b) \dots\dots\dots (5)$$

The description of Deep Learning is as follows (Nabipour, Nayyeri, Jabani, Shahab, & Mosavi, 2020).

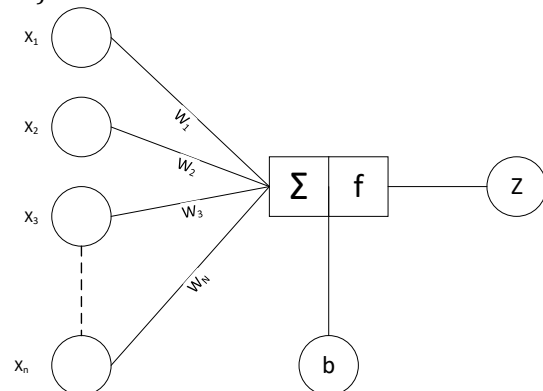


Figure 3 shows how the input and result of deep learning are related.

## 5. Evaluasi

In the evaluation step, a prediction process is used to compare the results of accuracy, f1 score, precision, recall, and auc success and error rates using two algorithms: traditional machine learning and deep neural networks.

## RESULTS AND DISCUSSION

There were 25,000 secondary data, with 11 characteristics and 1 class used in the monkeypox prediction study. In order to test smallpox disease predictions, this research compares the performance of deep neural network algorithms and more traditional machine learning algorithms. The calculations of qualitative and quantitative processing techniques based on the proposed model constitute the study's results. For this study, any accessed data sets may be used. The experiments and tests of this study forecast data sets using deep neural networks and conventional machine learning methods. The dataset used in this experiment has undergone pre-processing, feature selection, and modeling using Python at the Google Collaboratory, all of which have been used to verify the dataset.

### 1. Conventional Machine Learning Algorithms

The research will produce accuracy, f1 score, precision, recall, and aUC from the data of monkeypox patients used in Table 2 by pre-processing the data to produce values for several standard machine learning algorithms (random forest, decision tree, ada boost, xgboost, and SVM).

The conventional machine learning algorithm creates the XG Boost method from test data on monkeypox patients, which is superior to other

methods like the random forest, decision tree, Ada Boost, and SVM even though the average value difference is only 1-2%, as shown in Figure 4. It has an accuracy value of 60.40%, a f1 score of

65.39%, a precision of 64.45%, a recall of 64.40%, and an AUC of 64.40%.

Table 2. Value of Conventional Machine Learning Algorithm Pre-processing Results

Model	Accuracy	F1 Score	Precision	Recall	AUC
Random Forest	64,34%	64,58%	64,35%	64,34%	64,34%
Decision Tree	64,29%	64,05%	64,30%	64,29%	64,29%
Ada Boost	64,33%	64,03%	64,34%	64,33%	64,33%
XG Boost	64,40%	65,39%	64,45%	64,40%	64,40%
SVM	61,50%	60,45%	61,54%	61,50%	61,50%

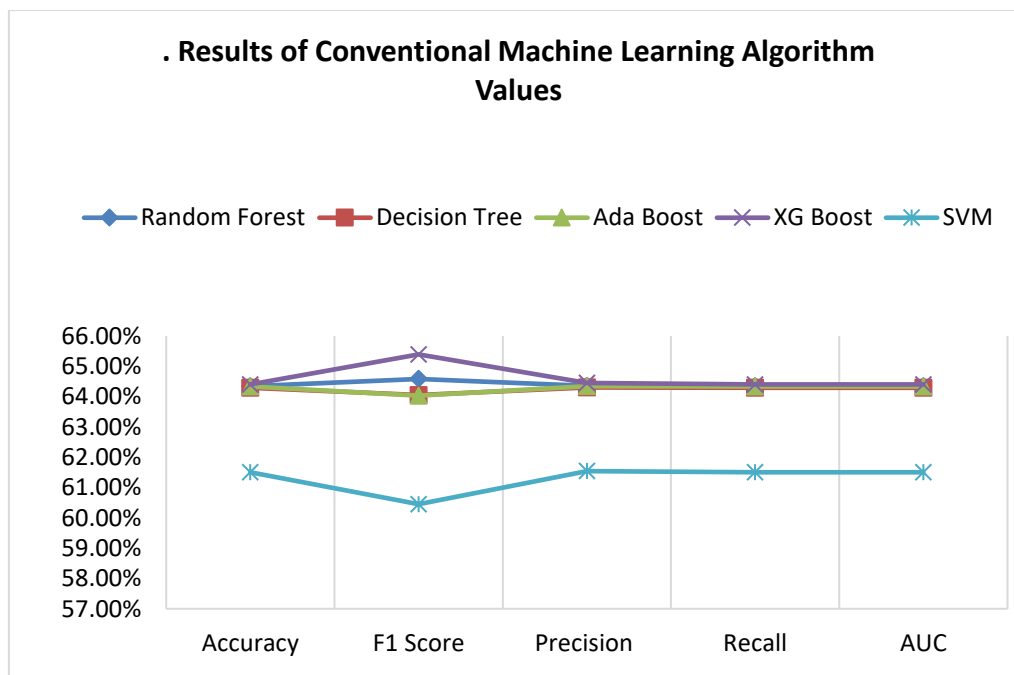


Figure 4. Results of Conventional Machine Learning Algorithm Values

## 2. Deep Neural Network Algorithms

After conventional machine learning algorithms, several techniques were employed in this research, including deep neural network algorithms with a range of 3–8 hidden layers. The test results from numerous iterations of the deep neural network method are compared in Table 2, along with accuracy values such as F1 Score, Precision, Recall, and AUC (Area Under Curve)—contrast patterns.

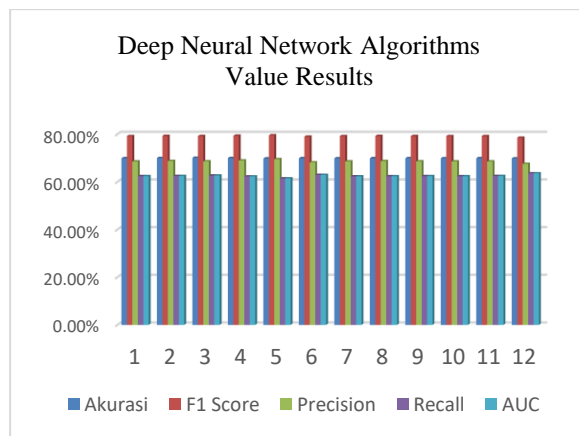
As shown in the graph of Figure 3, the tests for deep neural network algorithm optimization

with variations of four decoders (hidden layer encoder, sigmoid activation function parameters, Adagrad optimizer), with learning rate 0.01 and dropout 0.2, have a higher value than the deep neural network algorithm with other variations. This conclusion can be reached by analyzing the ROC curve and the confusion matrix for the above test findings.

Table 2 Results of the Deep Neural Network Algorithm

Result	Layers	Learning Rate	Accuracy	F1 Score	Precision	Recall	AUC
1	3 Hidden	0,01	69,89%	79,17%	68,55%	62,39%	62,39%
2	Decod -Encod	0,01	69,98%	79,26%	68,75%	62,43%	62,43%
3	3 Hidden Encod-Decod	0,01	70,08%	79,18%	68,59%	62,65%	62,65%
4	4 Hidden Decod -Encod	0,1	69,98%	79,33%	68,93%	62,26%	62,26%
5	4 Hidden Encod-Decod	0,1	69,80%	79,52%	69,49%	61,44%	61,44%
6	5 Hidden Decod-Decod	0,01	69,91%	78,94%	68,15%	62,88%	62,88%
7	5 Hidden Encod-Decod	0,01	69,86%	79,17%	68,56%	62,28%	62,28%
8	6 Hidden Decod-Encod	0,1	69,92%	79,23%	68,69%	62,33%	62,33%
9	6 Hidden Encod-Decod	0,01	69,91%	79,18%	68,59%	62,39%	62,39%
10	7 Hidden Decod-Encod	0,1	69,88%	79,17%	68,55%	62,35%	62,35%
11	7 Hidden Encod-Decod	0,1	69,92%	79,16%	68,54%	62,45%	62,45%
12	8 Hidden Decod-Encod	0,1	69,83%	78,50%	67,56%	63,57%	63,57%

Figure 4 Results and Values of the Deep Neural Network Algorithm



### 3. Comparison Models

The test findings from a comparison of traditional machine learning algorithms and deep neural networks are presented in Table 3.

Table 3. Results of the Comparison of Conventional Machine Learning and Deep Neural Algorithms

Layers	Learning Rate	Akurasi	F1 Score	Precision	Recall	AUC
4 Hidden Decod-Encod	0,01	70,08%	79,18%	68,59%	62,65%	62,65%
<i>XG Boost</i>		64,40%	65,39%	64,45%	64,40%	64,40%

As observed, the value of each algorithm in Table 3 is higher for the deep neural network algorithm than for the conventional machine learning algorithm.

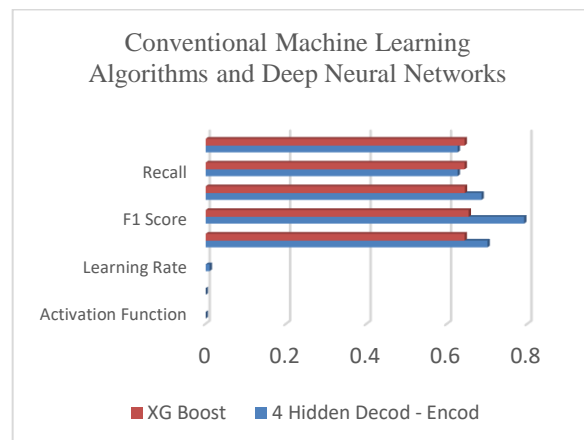


Figure 5. Results of Conventional Machine Learning and Deep Neural Network Algorithms

According to the test results above, which assess both the confusion matrix and the ROC curve, the tests conducted for optimizing the deep neural network algorithm with variations of four hidden layer decoders and encoders, sigmoid activation function parameters, and an AdaGrad optimizer with a learning rate of 0.01 and drop out of 0.2 have a higher value than using conventional machine learning algorithms.

The accuracy value of the deep neural network method is 70.08%, the F1 score is 79.18%, the precision is 68.59%, the recall is 62.65%, and the AUC is 62.65%. The xgboost algorithm's accuracy for the traditional machine learning model is 64.4%, its F1 score is 64.40%, its precision is 64.45%, its recall is 64.40%, and its AUC is 78.14%. The average accuracy difference is 5.68% on average, the F1 score is 13.79%, the precision is 4.14%, the recall is 1.75%, and the AUC is 1.75%, according to these figures.

## CONCLUSIONS AND SUGGESTIONS

### Conclusion

The study used pre-processing, data cleaning, feature selection, modeling, and evaluation, according to research using a data collection of monkey pox patients. With data cross-validation folds of 10, the deep neural network data method is a successful algorithm for the monkeypox dataset. With the sigmoid activation function parameter, Deep Neural Network gets an accuracy of 70.08%, an F1 score of 79.18%, a precision of 68.59%, a recall of 62.65%, and an AUC of 62.65%. Compared to traditional machine learning algorithms, the adagrad optimizer has a more excellent value with a learning rate of 0.01 and a dropout of 0.2. The xgboost model is 64.40%, the F1 score is 64.40%, the precision is 64.45%, the recall is 64.40%, and the AUC is 78.14%, which is the best when compared to other methods in the conventional machine learning algorithm. From this number, it can be deduced that the F1 score is 13.79%, the precision is 4.14%, the recall is 1.75%, and the AUC is 1.75%, and that the average accuracy gap between deep neural network algorithms and traditional machine learning is 5.68%.

### Suggestion

Based on the conclusions and observations made in the research, the suggestions made for the future in pre-processing can be developed for better operations optimization. The

data is still imbalanced due to class attributes; therefore, other techniques, such as PSO, can be used. Attributes can be added or subtracted from the depth of the data to get a better measurement.

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