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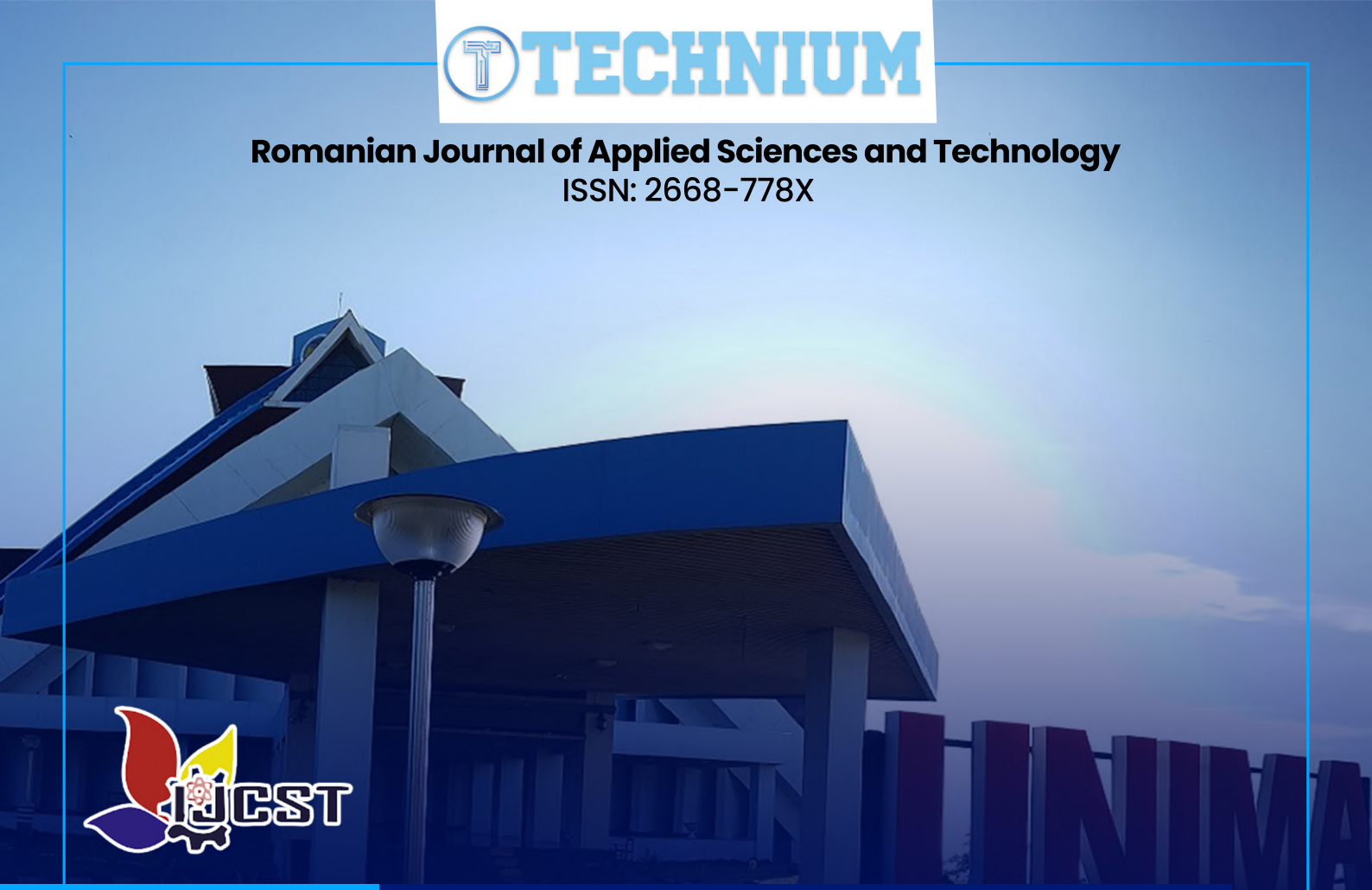

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Comparison of Deep Learning and MOORA Performance Methods in Multi Criteria Decision Making with Case Studies Best public health center

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Abstract. This research paper compares the performance of the deep learning and MOORA methods in making multi-criteria decisions to choose the best puskesmas. This paper discusses the methodologies used in both approaches, the architectures and equations used in deep learning, and the advantages and limitations of each method. The results show that the deep learning approach achieves 100% accuracy and the MOORA approach dss model obtains an accuracy of 95.75%.

Keywords. Public Health Center, Moora, Deep Learning, DSS

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1 Introduction

Public health center is a health service facility that organizes community health efforts and individual health efforts at the first level, by prioritizing promotive and preventive efforts in their working area[1].
A health worker is any person who is dedicated to the health sector and has knowledge and/or skills through education in the health sector which for certain types requires authority to carry out health efforts[2].
Public health centers have a very important role in achieving public health goals, especially for people who live in rural or remote areas in Indonesia[3]. Public health center services are also an important first step to identify health problems and ensure that people get the treatment they need in a timely manner[4]. However, there are also public health center medical personnel who are not good at doing their jobs, for example, they pay little attention to patients, excessive waiting times, examinations and treatment provided are not in accordance with medical standards and medical personnel are often absent or late, this can cause delays. in Health services and the lack of medical facilities and equipment that limits their ability to provide good and complete medical services.
One solution to this problem is to select the best public health center using the deep learning and MOORA methods. The results of the research focus on the Comparison of Deep Learning Methods and MOORA Performance on Multi Criteria which will later help determine the selection of the best Public health center which has the goal of quality health services and availability of adequate medical facilities and equipment to support the health services provided.

1.1 Deep Learning

Deep learning is a subset of machine learning that involves the use of neural networks with three or more layers[5]. These neural networks are designed to simulate the behavior of the human brain, allowing them to "learn" from large amounts of data[6]. Deep learning has gained significant attention and has been applied in various fields, including computer vision, natural language processing, and speech recognition. It is a key technology behind driverless cars, enabling them to recognize objects and make intelligent decisions. This model is show in Fig 1.

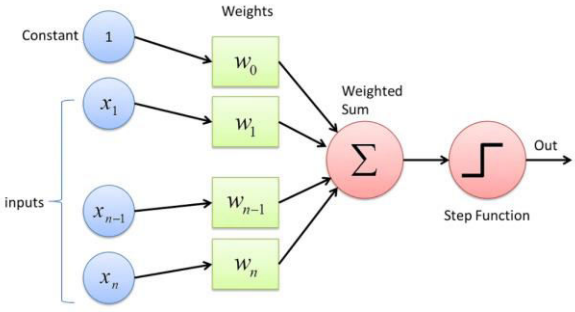

Fig. 1. Perceptron Model

The use of the perceptron was initially considered promising, because it offered a computational model that allows the learning process to derive the inherent pattern of a physical phenomenon[6] the perceptron was not able to solve a very simple problem, namely the XOR problem[7]. This finding then directs the use of perceptrons towards deep learning, where perceptrons are arranged into several layers, where each layer solves a problem or creates a feature which is a synthesis of several features in the previous layer. Deployment of deep learning improves the overall performance of this model.
Deep learning itself is part of the scope of machine learning methods based on neural networks[8]. The use of deep learning can be supervised, semi-supervised, or unsupervised[9]. The use of deep learning itself can be stated based on the architecture used, including deep neural networks, deep belief networks, recurrent neural networks, and convolutional neural networks[10], where these architectures have been applied to the realms of image recognition, speech recognition, natural language processing. NLP), translation, bioinformatics, drug design, to medical image analysis[11].
The use of the term deep in deep learning refers to the use of multiple layers within the neural network architecture used[12]. Meanwhile, in deep learning architecture, more than a hidden layer is used, as show in Fig 2.

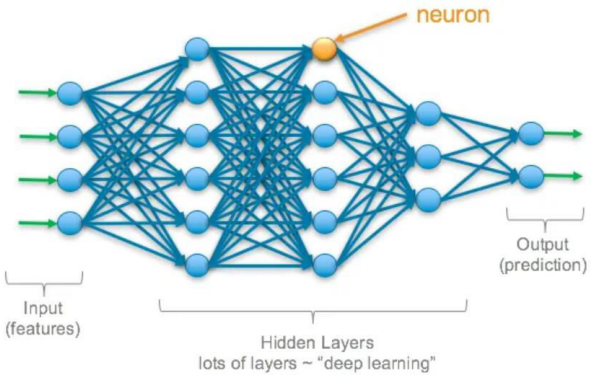

Fig. 2. Deep learning architecture

Deep learning does not have one common mathematical equation as in pure mathematics[13]. However, there are several equations that are used in the construction and training of neural networks, which are the foundation of deep learning[14].
One of the important equations in deep learning is the equation for calculating the activation of each neuron in the network[15]. Suppose x is the input vector in a layer, and w is the weight vector, and b is the bias, then the equation for computing activation (z) in that layer using the activation function (f) is:

$$z = w * x + b \quad (1)$$
$$a = f(z) \quad (2)$$

Here, a is the output of the neuron after passing through the activation function. Some of the commonly used activation functions are ReLU.

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$(f(z) = max(0,z)), Sigmoid\ (f(z) = 1 / (1 + exp(-z))), dan\ Tanh\ (f(z) = (exp(z) - exp(-z)) / (exp(z) + exp(-z)))$. (3)

Moreover, in training a neural network, we use equations to calculate the gradient of the loss function (L) against the weights (w) in the network. Suppose y is the desired output (ground truth) and y_hat is the output generated by the network, then the equation for the gradient (dL/dw) is:

$$dL/dw = (1/n) * \Sigma(dL/dy\_hat * dy\_hat/dz * dz/dw) \quad (4)$$

Σ = sum symbol,
n = amount of training data,
dL/dy_hat = the gradient of the loss function to the resulting output,
dy_hat/dz = gradient of the activation function with respect to the input,
dz/dw = gradient from activation to weight.

1.2 Multi-Objective Optimization by Ratio Analysis (MOORA)

The MOORA method was introduced by Brauers & Zavadskas where this method is a multi-objective optimization technique that can be successfully applied to solving various types of complex decision-making problems in a manufacturing environment[16].
Multi-criteria decision-making method used to select the best alternative from a group of alternatives based on several predetermined criteria or objectives[17]. The MOORA method helps simplify and speed up the decision-making process by ranking each alternative based on a comparison[18] of the ratio to the weight of the criteria[19]. Following are the general steps in the MOORA method:

Define Criteria and Weights: Identify relevant criteria or objectives for decision making and assign a weight to each of them[20]. The weight reflects the importance level of each criterion in the final decision.

1. Data Normalization: Perform data normalization to change the value of each criterion into the range 0 to 1. Normalization can be done by calculating the standardized value of each criterion with the following formula:

$$X\_ij = (X\_ij - min(X\_j)) / (max(X\_j) - min(X\_j)) \quad (5)$$

X_ij = standardized value of alternative i on criterion j,
X_ij = the original value of alternative i on criterion j,
min(X_j) = minimum value of criterion j,
max(X_j) = the maximum value of criterion j.

2. Calculate Relative Value: After getting the standardized value for each alternative and criteria, calculate the relative value for each alternative against each criterion by multiplying the standardized value with the corresponding weight:

$$R\_ij = X\_ij * W\_j \quad (6)$$

R_ij = relative value of alternative i on criterion j,
X_ij = standardized value of alternative i on criterion j, W_j = weight of criterion j.

3. Calculate Aggregate Score: Calculate the aggregate score for each alternative by adding up the relative scores for all criteria with their corresponding weights:

$$V\_i = \Sigma(R\_ij) = R\_i1 + R\_i2 + R\_i3 \quad (7)$$

V_i = the aggregate value of alternative i,
R_ij = relative value of alternative i on criterion j,
Σ = sum symbol.

4. Choose the Best Alternative: Choose the alternative with the highest aggregate value as the best alternative in the context of the specified criteria.

2 Research Methodology

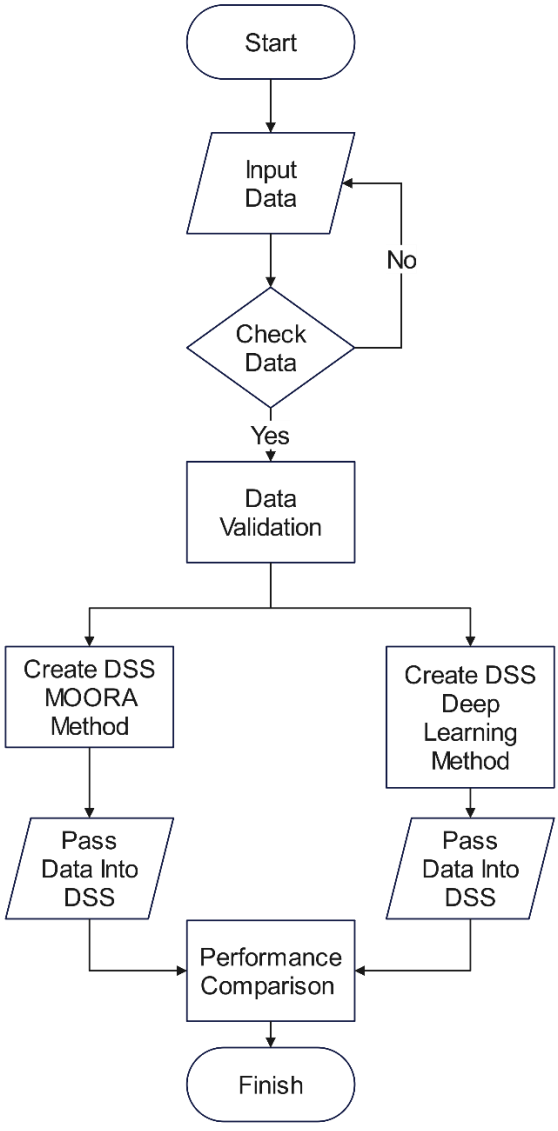

Fig. 3. Flowchart of research stages

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Metode Multi-Objective Optimization by Ratio Analysis (MOORA)

At this stage, normalization aims to unite each matrix. element so all elements in the matrix have the same value.

$$X_{ij}^{*} = X_{ij} / \sqrt{\left[\sum_{j=1}^{m} X_{ij}^{2}\right]} \quad (8)$$

Calculate the value of optimization Calculating the value of this optimization can be done in two ways, namely if the criteria have weights and do not have weights. If the criteria have weights, it indicates that an attribute or criterion that is more important can be multiplied by the appropriate weights. Can use the following equation

$$Y_i = \sum_{j=1}^{g} w_j x_{ij}^{*} - \sum_{j=g+1}^{n} w_j x_{ij}^{*} \quad (9)$$

If the criteria have no weight. Can use the following equation

$$Y_i = \sum_{j=1}^{i=g} w_j x_{ij}^{*} - \sum_{j=g+1}^{i=n} w_j x_{ij}^{*} \quad (10)$$

Determine the ranking of the results of MOORA calculation.

The criteria data required in the DSS selection process of the best practical work students at the Politeknik Bisnis Indonesia with the MOORA method consists of Discipline (C1), Medical Equipment (C2), Staff Integrity (C3), Communication (C4), Stock medicine (C5). Criteria data and weights for each criterion can be seen in table 1.

Table 1. Criteria data and weight

Criterion	Information	Weight	Weight
CI	Medical Equipment	25	Benefits
C2	Staff Integrity	20	Benefits
C3	Communication	25	Benefits
C4	Stock medicine	30	Cost

Moreover, in this study, table 2 presents data for each alternative and the value of each criterion

Table 2. Alternative match ratings and criteria

Alternative	Alternative Name	C1	C2	C3	C4
A1	Levi	80	70	90	70
A2	Rindu	70	80	70	80
A3	Cahaya	60	70	70	80
A4	Purnama	70	75	65	75
A5	Vira	65	75	75	55
A6	Bobo	75	60	70	65

Deep Learning Method

This model receives input data from the input layer, and then forwards it to the processing layers, or is called the hidden layer. The processing results will then be displayed as a value in the output section, where this value is a probability value, or recommendation, that a student is eligible to be proposed into a scholarship category. Calculations for each hidden layer will use neurons with a perceptron computational model, according to Equation (11). In this equation, there are i inputs for an output on the j perceptron.

$$y_j = f_a\left(w_{1,j}.x_1 + w_{2,j}.x_2 + \cdots + w_{i,j}.x_i + b_j\right) \quad (11)$$

y: perceptron external element
x : perceptron input element
fa : activation function
b : bias
w: weight
i: input index
j: output index
n: input index to n

After making this deep learning model, a training process will be carried out on the model. This training aims to change the parameters contained in the model, namely weight and bias in it. Changes to the parameters in this model will be based on the Stochastic Gradient Descent method, where the current parameter values will be entered into the cost function to determine updates to the parameters owned, to reduce the cost function. This cost function is show in Equation.

$$f_c(m,b) = \frac{1}{n}\sum_{i=1}^{n}\left(h_\theta(x_i)\right) - y_i \quad (12)$$

f_c = cost function
m = weight
b = bias
n = the number of evaluation data, in this study using 32 data per batch
h_θ = prediction function with m and b as parameters
x_i = input data to i
y_i = output data to i

Based on the resulting cost, all the parameters contained in this deep learning model will be updated with the aim of reducing costs, which is expected to ultimately increase the accuracy of this model.

3 Results and Discussion

Data analysis using the MOORA method consists of the following steps:

Based on the alternative data in Table 2, the next step is to normalize the matrix to calculate each criterion value. The results of the calculation of the Xij Normalized Decision Matrix can be seen in matrix below.

Table 3. Normalize the decision matrix

0.2580	0.2258	0.2903	0.2258
0.2333	0.2666	0.2333	0.2666
0.2142	0.25	0.25	0.2857
0.2456	0.2631	0.2280	0.2631
0.2407	0.2777	0.2777	0.2037
0.2777	0.2222	0.2592	0.2407

The next stage is weighting the data from the normalization results above using the weights listed in table 4. The multiplication results of the Weighted Normalization Data can be seen in the matrix below.

Table 4. Calculate the weighted normalized decision matrix :

0.0645	0.0451	0.0725	0.0677
0.0583	0.0533	0.0583	0.08

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0.0535	0.05	0.0625	0.0857
0.0614	0.052	0.057	0.0789
0.0601	0.0555	0.0694	0.0611
0.0694	0.0444	0.0648	0.0722

The Next stage is Calculate the scores for each alternative can be seen in the matrix below :

Table 5. Calculate the scores :

Alternative	Score
A1	0.25
A2	0.25
A3	0.2517
A4	0.2499
A5	0.2462
A6	0.2509

From the calculation of the value of Yi, the best ranking results are: A3 with the value of Yi = 0.2517. Ranking Result Graph can be seen visually

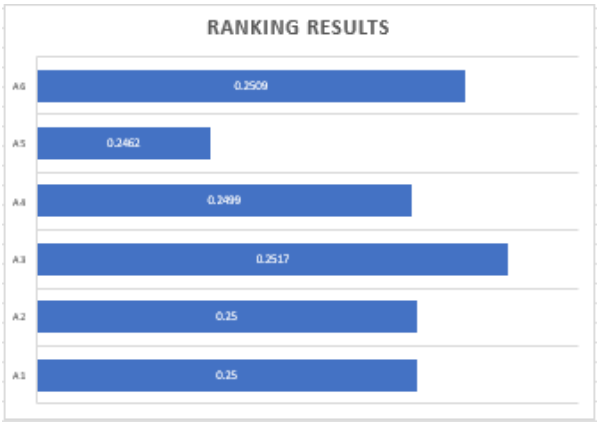

Fig. 4. Ranking Result Graph

DSS Deep Learning

At this stage, the algorithm for optimization uses adam's algorithm, while for loss calculations it will use the binary_crossentropy approach Adam is an optimization algorithm that can help train your neural network. It stands for Adaptive Moment Estimation and is a very effective gradient descent algorithm used to optimize loss functions.

Adam works by calculating an exponential moving average of the gradient and the squared gradient. This helps the algorithm adapt to the geometry of the loss function. The exponential moving average means recent gradients are given more weight than older gradients. Can be seen in table below

Table 6. Calculate the weighted normalized decision matrix :

Num	Parameters	Value
1	Optimizer	Adam
2	Loss	Binary_crossentropy
3	Metrics	Binary_accuracy
4	Callbacks	Early Stopping

Then the best health center prediction model training was carried out. Shown in Figure 5, it is found that the minimum loss value is close to 0 with an accuracy value of 100%

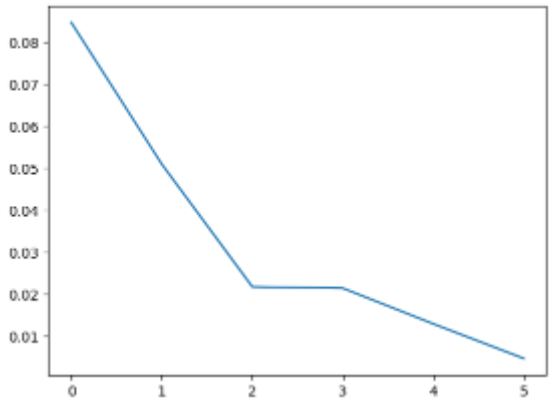

Fig. 4. Graph of training loss value against training model

This research activity has been carried out, the results of this study include the accuracy performance of the two approaches that have been found, the first approach uses the MOORA calculation. The second approach uses a deep learning approach based on deep learning. The results of the two approaches are shown in table 7.

Table 7.Performance Comparison:

Num	Scheme	MOORA	Deep Learning
1	Best public health center	95,75%	100%

From the examination results obtained, it can be concluded several things that might lead to these results.

1. The MOORA method heavily relies on the assignment of weights to the criteria. Determining the appropriate weights can be challenging, and different stakeholders may have different opinions, leading to subjective outcomes
2. The MOORA method can be sensitive to outliers or extreme values in the data, which may significantly influence the final rankings.
3. Training deep learning models can be computationally intensive and requires specialized hardware like GPUs or TPUs. This can be a barrier for individuals or organizations with limited computational resources

CONCLUSION

The DSS model with the MOORA approach was successfully created, with an accuracy performance of 95.7% while the DSS model with a deep learning approach with an accuracy performance of 100%

References

[1] 'BERITA NEGARA REPUBLIK INDONESIA'. [Online]. Available: www.peraturan.go.id

[2] A. Perencanaan *et al.*, 'Planning Analysis of Health Human Resource in Health Office Southeast Minahasa District'.

[3] A. Irawan, S. Ipnuwati, A. Tardiansyah, and A. Maseleno, 'The Best Public Health Center Selection Decision Support System Using Simple Additive Weighting (SAW) and Weighted Product (WP) Methods', *Journal of Artificial Intelligence, Machine Learning and Neural Network*, no. 21, pp. 9–26, Jan. 2022, doi: 10.55529/jaimlnn21.9.26.

[4] W. W. Yahya and F. Riandari, 'Decision Support System in Determining the Location of Village Health Services (Puskesmas) in Pagar Merbau District Using the Profile Matching Method', 2021.

[5] M. Gabrié, S. Ganguli, C. Lucibello, and R. Zecchina, 'Neural networks: from the perceptron to deep nets', Apr. 2023, [Online]. Available: http://arxiv.org/abs/2304.06636

[6] R. Fakoor, A. Nazi, and M. Huber, 'Using deep learning to enhance cancer diagnosis and classification', 2013.

[7] Y. S. Park and S. Lek, 'Artificial Neural Networks: Multilayer Perceptron for Ecological Modeling', in *Developments in Environmental Modelling*, Elsevier B.V., 2016, pp. 123–140. doi: 10.1016/B978-0-444-63623-2.00007-4.

[8] N. Setiawan *et al.*, 'Simple additive weighting as decision support system for determining employees salary', 2018. [Online]. Available: https://www.researchgate.net/publication/326345853

[9] O. Ghorbanzadeh, T. Blaschke, K. Gholamnia, S. R. Meena, D. Tiede, and J. Aryal, 'Evaluation of different machine learning methods and deep-learning convolutional neural networks for landslide detection', *Remote Sens (Basel)*, vol. 11, no. 2, Jan. 2019, doi: 10.3390/rs11020196.

[10] S. Nosratabadi *et al.*, 'Data science in economics: Comprehensive review of advanced machine learning and deep learning methods', *Mathematics*, vol. 8, no. 10. MDPI AG, pp. 1–25, Oct. 01, 2020. doi: 10.3390/math8101799.

[11] Y. Shirvany, M. Hayati, and R. Moradian, 'Multilayer perceptron neural networks with novel unsupervised training method for numerical solution of the partial differential equations', *Applied Soft Computing Journal*, vol. 9, no. 1, pp. 20–29, Jan. 2009, doi: 10.1016/j.asoc.2008.02.003.

[12] E. Vanzella *et al.*, 'Photometric redshifts with the multilayer perceptron neural network: Application to the HDF-S and SDSS', *Astron Astrophys*, vol. 423, no. 2, pp. 761–776, Aug. 2004, doi: 10.1051/0004-6361:20040176.

[13] A. A. Almazroi, E. A. Aldhahri, S. Bashir, and S. Ashfaq, 'A Clinical Decision Support System for Heart Disease Prediction using Deep Learning', *IEEE Access*, 2023, doi: 10.1109/ACCESS.2023.3285247.

[14] R. Anantama, H. Suyono, and M. Aswin, 'APPLICATION OF COST-SENSITIVE CONVOLUTIONAL NEURAL NETWORK FOR PNEUMONIA DETECTION', vol. 11, no. 3, 2022.

[15] M. Desai and M. Shah, 'An anatomization on breast cancer detection and diagnosis employing multi-layer perceptron neural network (MLP) and Convolutional neural network (CNN)', *Clinical eHealth*, vol. 4. KeAi Communications Co., pp. 1–11, Jan. 01, 2021. doi: 10.1016/j.ceh.2020.11.002.

[16] S. Dedi Arnold Pardede, A. Harahap, A. Putera Utama Siahaan, K. Kunci, S. Peserta Jamkesmas, and S. Pendukung Keputusan, 'Sistem Pendukung Keputusan Pemilihan Peserta Jaminan Kesehatan Masyarakat (Jamkesmas) Menerapkan Metode MOORA', vol. 2, no. 2, 2018, [Online]. Available: http://ejurnal.stmik-budidarma.ac.id/index.php/mib|

[17] F. Agustina, A. T. Sumpala, and A. Arysespajayadi, 'SPK Pemilihan Jurusan Siswa Baru Menggunakan Metode AHP dan MOORA Pada SMKN 1 Kolaka', *Jurnal Sains dan Informatika*, vol. 7, no. 1, pp. 87–96, Jul. 2021, doi: 10.34128/jsi.v7i1.292.

[18] S. Fadli and K. Imtihan, 'Implementation of MOORA Method in Evaluating Work Performance of Honorary Teachers', *SinkrOn*, vol. 4, no. 1, p. 128, Oct. 2019, doi: 10.33395/sinkron.v4i1.10192.

[19] S. Rokhman, F. Rozi, and R. A. Asmara, 'PENGEMBANGAN SISTEM PENUNJANG KEPUTUSAN PENENTUAN UKT MAHASISWA DENGAN MENGGUNAKAN METODE MOORA STUDI KASUS POLITEKNIK NEGERI MALANG', 2017.

[20] V. M. M. Siregar, M. R. Tampubolon, E. P. S. Parapat, E. I. Malau, and D. S. Hutagalung, 'Decision support system for selection technique using MOORA method', *IOP Conf Ser Mater Sci Eng*, vol. 1088, no. 1, p. 012022, Feb. 2021, doi: 10.1088/1757-899x/1088/1/012022.