TIERS Information Technology Journal
Vol.4, No.2, December 2023, pp. 129~133
ISSN: 2723-4533 / E-ISSN: 2723-4541
DOI: 10.38043/tiers.v4i2.5515

Meta-Analysis Of Genetic Algorithm Implementation For Optimization Of Artificial Neural Network Methods

Komang Nova Artawan[1], Agus Dharma[2], I Made Ardi Sudestra
komang.nopha@gmail.com[1], agus_dharma@unud.ac.id, ardi.sudestra@student.undiksha.ac.id[3]
[1,3] Electrical Engineering, Universitas Udayana, Bali, Indonesia
[2] Computer Science, Universitas Pendidikan Ganesha, Bali, Indonesia

ABSTRACT

One artificial intelligence method, artificial neural networks, has been widely used in data analysis to make predictions, forecasting, and data classification. The artificial neural network method has convergence or local minimum problems because it requires randomly generated weight values. Much research discusses optimization techniques for initiating this initial weight to solve that problem. This study conducted a meta-analysis regarding implementing genetic algorithms to optimize artificial neural network methods. Based on ten journals reviewed in this study, it was concluded that optimization of the genetic algorithm can increase the output value of the artificial neural network by 3.44%. Still, this genetic algorithm optimization has no significant effect based on the sig (2-tailed) value of 0.595. The t-count value of 0.551 has been obtained and tested using the paired samples t-test method with the help of S.P.S.S. software.

Keywords: Meta-Analysis; Artificial Intelligence; Artificial Neural Network;

Article Info

Accepted : 10-12-2023
Revised : 07-09-2023
Published Online : 25-12-2023

Correspondence Author:

Komang Nova Artawan
Electrical Engineering,
Universitas Udayana,
Jl. Raya Kampus UNUD, Bukit Jimbaran, Kuta Selatan, Badung, Bali 80361
Email: komang.nopha@gmail.com

1. INTRODUCTION

The optimization of neural networks is a critical area of research, particularly as these models are increasingly applied in classification, prediction, and forecasting tasks across various domains. The complexity of neural networks often necessitates sophisticated optimization techniques to enhance their performance, accuracy, and generalization capabilities. Genetic Algorithms (GAs), inspired by the principles of natural selection, have emerged as a powerful optimization tool in this context. They are particularly effective in navigating the vast search spaces associated with neural network parameters, thereby improving model training and performance outcomes [1][2].

Recent studies have demonstrated the efficacy of combining Genetic Algorithms with neural networks to address specific challenges in various applications. For instance, explored the integration of GAs with neural networks for stock market prediction, highlighting how this hybrid approach can significantly enhance predictive accuracy compared to traditional methods [3]. Similarly, presented a hybrid evolutionary functional link artificial neural network that leverages GAs for data mining and classification tasks, showcasing the versatility of this optimization technique [4]. These examples underscore the growing recognition of GAs as a vital component in optimizing neural network architectures and training processes.

Despite the promising results achieved through the application of Genetic Algorithms in neural network optimization, there remain significant research gaps that warrant further exploration. Many existing studies focus on specific applications or datasets, often neglecting broader generalizability and scalability issues. For example, while the combination of GAs and neural networks has shown success in domains like finance and healthcare, there is a need for comprehensive investigations into their applicability across diverse fields and varying data characteristics [5][6]. Furthermore, the potential for GAs to enhance the interpretability of neural networks, which is crucial for many real-world applications, has not been sufficiently addressed in the literature [2].

Neural network method is based on biological neural networks in living things, implemented as a system of simple interconnected processing elements, and described functionally as units or nodes [2]. The connections between different nodes have numerical values called weights; based on the weights and the modifications that can be made to those values systematically, these networks can eventually perform a specified function. Each node in the network takes multiple inputs from other nodes and calculates a single output value based on the inputs and weights of the connections. This output is generally fed to other neurons, and the process repeats until the best output value is obtained based on predefined error criteria to obtain the minimum possible error value.

Neural network method are widely used to solve a wide variety of problems, from relatively simple classification problems, prediction, and forecasting to speech recognition and computer vision. The artificial neural network method requires a large amount of data to be learned, along with the output value or label of the data. Using pairs of data and outputs given, this method learns patterns from the data to get the expected results, which is why it is widely used in research by large businesses due to its fast learning ability.

In addition, there are also many discussions about optimization techniques that can be applied to this artificial neural network method because a weight value is needed to translate input data so that it can be processed in the processing network (hidden layer). This weight value is generally generated randomly, and this will cause convergence or local minimum problems [5]. Therefore, many researchers propose the application of optimization methods such as genetic algorithms, PSO, and others to generate optimal weight values at the beginning so that these optimal weights will be able to reduce the risk of the above problems and can increase the accuracy value or reduce the range of error values of a data classification or prediction case.

Based on these problems, researchers want to conduct literature review research with the meta-analysis method on several research journals related to genetic algorithm optimization to determine how it affects the artificial neural network method. The potential impact of this research is significant, as it could pave the way for more accurate and efficient data analysis methods.

2. RESEARCH METHOD

This research employs a systematic literature review methodology in conjunction with a meta-analytic approach to extract data from scholarly research journals. These journals, which concentrate on the application of Genetic Algorithms for the optimization of neural network methodologies in the contexts of classification, prediction, and forecasting, are obtained from diverse online repositories. The research methodology comprises multiple phases, commencing with the articulation of the research problem, followed by the identification of pertinent literature, and culminating in the examination of the selected journals to formulate conclusions pertinent to the research problem.

The study population is constituted by a compendium of scientific journals, from which a sample of 10 relevant journal articles is meticulously chosen. Data collection is executed through the documentation of research outcomes derived from these sampled articles. The instrument employed in this study involves a comprehensive review of the sampled journals, with the findings presented in a tabular format that delineates test values prior to and subsequent to the optimization utilizing the Genetic Algorithm.

3. RESULTS AND DISCUSSION

In this result and discussion, a review of research journals sampled in this study is carried out. The review results are summarized in a table containing data that compares the output value of artificial neural networks before optimization with the output value after optimization with genetic algorithms. The values used for comparison in this study include accuracy, fitness, and error values (RMSE). Below is a complete table of discussion results from the journals reviewed in this study:

.

Table I. Journal review results of genetic algorithm optimization on artificial neural networks

No.	Title	Author (year)	Genetic Algorithm Optimization Results	
			Before	After
1	Artificial Neural Network Weighting Optimization in Breast Cancer Classification	Kiki Dwi Prebiana, I Gede Santi Astawa, and I Wayan Supriana (2020)	96.6% to 99.0% accuracy	98.5% to 99.5% accuracy
2	Weight Value Optimization of Backpropagation Neural Network Algorithm with Genetic Algorithm	Moh. Dasuki (2021)	RMSE value of 0.120	RMSE value of 0.115
3	Genetic Algorithm Optimization with Artificial Neural Network for Image Classification	Finki Dona Marleny, Mambang (2019)	86% Accuracy	92% Accuracy
4	Optimization of Artificial Neural Network with Genetic Algorithm on Inflow Discharge Prediction of Sengguruh Reservoir	Yandria Elmasari and Nurhadi (2019)	Fitness value 0.180858	Fitness value 0.157
5	Forecasting Optimization of the Number of Disease Cases Using the Backpropagation Artificial Neural Network Method with Genetic Algorithm	Gilang Ramadhan, Budi Darma Setiawan, and Marji (2018)	Accuracy value 85.8%	Accuracy value of 87.2%
6	GENETIC ALGORITHM-BASED NEURAL NETWORK FOR EMPLOYMENT PREDICTION	ST. Aminah Dinayati Ghani, Purwanto, Chess Supriyanto (2018)	Accuracy Value 87.45%	Accuracy Value 88.30%
7	Application of Genetic Algorithm Using Radial Basis Function To Predict Consumer Price Index in Pekanbaru City	Fahrurrozi Harahap, Fitri Insani, Benny Sukma Negara, Yusra (2022)	MAPE Error Value 0.298	Error value MAPE 0.111
8	Artificial Neural Network Optimization with Genetic Algorithm on Credit Card Approval Prediction	Ipin Sugiyarto, Umi Faddillah (2017)	Accuracy Value 85.42%	Accuracy value of 87.82%.
9	Artificial Neural Network Parameter Optimization Using Genetic Algorithm for Student Graduation Prediction	Irfan Ali, Lana Sularto (2019)	Accuracy Value 71.48%	Accuracy Value 99.33%
10	Neural Network Optimization Using Genetic Algorithm to Predict the Number of Tourist Visits	Fatimatuzzahra, Rifqi Hammad, Ahmad Zuli Amrullah, Pahrul Irfan (2022)	RMSE value 0.050	RMSE value 0.044
		Average (Decimal)	**5,76508**	**5,9635**

Based on the results of the table above, the previous artificial neural network output values will be converted into decimal form, then calculated the total average value of each artificial neural network output using genetic algorithm optimization with those not using optimization. It was found that the average value of artificial neural network output without optimization with a genetic algorithm was 5.76508, while for the average value of artificial neural network output with genetic algorithm optimization was 5.9635. To determine the percentage increase in the average output of artificial neural networks using genetic algorithms, the following formula is used:

$$persentase(\%) = \frac{nilai\ akhir - nilai\ awal}{nilai\ awal} \times 100\%$$

$$persentase(\%) = \frac{5{,}9635 - 5{,}76508}{5{,}76508} \times 100\%$$

$$persentase(\%) = \frac{0.19842}{5.76508} \times 100\%$$

$$persentase(\%) = 0.0344 \times 100\% = 3.44\%$$

Descriptively, it can be concluded that the use of genetic algorithms for artificial neural network optimization provides an increase in the output value, where the percentage results show that the output value of the artificial neural network has increased by 3.44% by using genetic algorithms. Then analyze the results of the test output using the Paired Sample T-Test method with the help of SPSS software.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Sebelum - Sesudah	-.01952000	.11207172	.03544019	-.09969128	.06065128	-.551	9	.595

Figure 1. Results of paired samples t-test analysis with SPSS

Figure 1 shows the results of SPSS data processing to determine the significance of changes in artificial neural network output values before and after optimization using genetic algorithms. The reference in the figure is the sig (2-tailed) value. According to Santoso (2014: 256) the sig (2-tailed) value is the significance value of the results which is the basis for whether the initial hypothesis (Ho) or the alternative hypothesis (Ha) will be accepted in a study [1]. If the Sig. (2-tailed) value is <0.05 then Ho is rejected and Ha is accepted, while if the Sig. (2-tailed) value is >0.05 then Ho is accepted and Ha is rejected. The initial hypothesis in this study is that genetic algorithm optimization has no significant effect on artificial neural network output, and the alternative hypothesis is that genetic algorithm optimization has a significant effect on artificial neural network output. Based on the results in Figure 1, it is known that the sig (2-tailed) value is 0.595, where the value is greater than 0.05, so it can be concluded that Ho is accepted, and Ha is rejected, which means that genetic algorithm optimization has no significant effect on artificial neural network output.

In addition, hypothesis testing is also carried out using a comparison of the calculated t value with the t table, according to Sugiyono (2016: 97), if the calculated t value is in the Ho acceptance area or is between the t table prices, then Ho is accepted and Ha is rejected. So, if the calculated t value is smaller or equal to the t table value, then Ho is accepted and Ha is rejected. On the other hand, if the calculated t value is greater than the t table value, then Ho is rejected and Ha is accepted.

The t value in Figure 1 is -0.551, which means that the output value of the artificial neural network before optimization with the genetic algorithm is lower than after optimization. However, for this hypothesis test, the t value is an absolute value, so the negative value will be converted to positive, so the t value will be 0.551. In finding the t table value, it can be found based on the degree of freedom (df), with the amount of n-1, which is the amount of data - 1 = 9. By using the degree of error (α) of 5%, the t table value is 1.833.

Since the calculated t value (0.551) is smaller than the t table value (1.833), it can be concluded that Ho is accepted and Ha is rejected, so the conclusion is that genetic algorithm optimization has no significant effect on artificial neural network output.

4. CONCLUSION

Based on the results of testing the output value of the artificial neural network before and after optimization with a genetic algorithm, it is known that genetic algorithm optimization provides an increase in the output value with a percentage of 3.44%, but when paired sample t - test is carried out with the help of SPSS software, by testing the sig value (2-tailed) and the calculated t value, it is concluded that genetic algorithm optimization has no significant effect on the output of the artificial neural network. This is because the change in the output value of the artificial neural network according to table 1 does not change significantly, some values only change below 5%.

REFERENCES

[1] A. Yaqien, "A Meta-Analysis of the Use of Computer-Based Learning Media in Improving Student Learning Outcomes," *Journal of Building Engineering Education Studies (JKPTB)*, vol. 7, no. 2, 2021.

[2] F. D. Marleny, and M. Mambang, "Genetic Algorithm Optimization with Artificial Neural Network for Image Classification," *JTIULM*, vol. 4, no. 1, pp. 1-6, Apr. 2019.

[3] K. D. Prebiana, I. G. S. Astawa, and I. W. Supriana, "Optimization of Artificial Neural Network Weighting in Breast Cancer Classification," *Electronic Journal of Udayana Computer Science*, vol. 9, no. 1, Aug. 2020.

[4] Y. Elmasari, and Nurhadi, "Optimization of Artificial Neural Network with Genetic Algorithm on Prediction of Inflow Debit of Sengguruh Dam," *JIPI (Scientific Journal of Informatics Research and Learning)*, vol. 4, no. 2, pp. 122-126, Dec. 2019.

.

[5] M. Dasuki, "Optimization of the Weight Value of the Backpropagation Neural Network Algorithm with Genetic Algorithms," *JUSTINDO (Indonesian Journal of Information Systems & Technology)*, vol. 6, no. 1, Feb. 2021.

[6] G. Ramadhan, B. D. Setiawan, and Marji, "Forecasting Optimization of the Number of Disease Cases Using the Backpropagation Artificial Neural Network Method with Genetic Algorithms," *Journal of Information Technology and Computer Science Development*, vol. 2, no. 8, pp. 2800-2809, Aug. 2018.

[7] S. T. Ghani, A. D. Purwanto, and C. Supriyanto, "Genetic Algorithm-Based Neural Network for Job Opportunity Prediction," *Journal of Informatics Education*, vol. 1, no. 1, Apr. 2018.

[8] F. Harahap, F. Insani, B. S. Negara, and Yusra, "Application of Genetic Algorithm Using Radial Basis Function for Consumer Price Index Prediction in Pekanbaru City," *National Journal of Computing and Information Technology*, vol. 5, no. 3, Jun. 2022.

[9] I. Sugiyarto, and U. Faddillah, "Optimization of Artificial Neural Network with Genetic Algorithm on Credit Card Approval Prediction," *Journal of Informatics Engineering STMIK Antar Bangsa*, vol. 3, no. 2, Aug. 2017.

[10] I. Ali, and L. Sularto, "Optimization of Artificial Neural Network Parameters Using Genetic Algorithm for Student Graduation Prediction," *ICT Journal: Information Communication & Technology*, vol. 18, no. 1, pp. 54-59, Jul. 2019.

[11] F. Hammad, A. Rifqi, A. Z. Ahmad, and P. Irfan, "Neural Network Optimization Using Genetic Algorithms for Predicting the Number of Tourist Visits," *JTIM: Journal of Information Technology and Multimedia*, vol. 3, no. 4, pp. 227-235, Feb. 2022.

[12] B. Hirianskyi, "A review of practice of using evolutionary algorithms for neural network synthesis and training", Technology Audit and Production Reserves, vol. 4, no. 2(72), p. 22-26, 2023. https://doi.org/10.15587/2706-5448.2023.286278

[13] R. Mahajan and G. Kaur, "Neural networks using genetic algorithms", International Journal of Computer Applications, vol. 77, no. 14, p. 6-11, 2013. https://doi.org/10.5120/13549-1153

[14] W. Zhou, Y. Zhao, W. Chen, Y. Liu, R. Yang, & Z. Liu, "Research on investment portfolio model based on neural network and genetic algorithm in big data era", Eurasip Journal on Wireless Communications and Networking, vol. 2020, no. 1, 2020. https://doi.org/10.1186/s13638-020-01850-x

[15] F. Mili and M. Hamdi, "A hybrid evolutionary functional link artificial neural network for data mining and classification", International Journal of Advanced Computer Science and Applications, vol. 3, no. 8, 2012. https://doi.org/10.14569/ijacsa.2012.030815