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*Research Article*

# Application of Optimized BP Neural Network Model for the Training Load Prediction in Physical Education Teaching

**Xiangxue Cheng**

*Physical Education Center, Xijing University, Xi'an, Shaanxi, China*

Correspondence should be addressed to Xiangxue Cheng; 201701340132@lzpcc.edu.cn

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Load prediction is mandatory for analyzing the working condition of the teachers when new courses are to be introduced or change in the learning environment. During complex environment, the seasonal prediction about sports has to be analyzed and designs the physical education training program for the students to increase the fitness of the students. In this study, load prediction in physical education is performed with the implementation of a back propagation neural network model with the support of genetic algorithm and termed as BPNNGA. The proposed prediction algorithm is compared with the existing algorithms such as back propagation neural network, *K*-means neural network, and random forest algorithm. The results proved that the proposed algorithm outperforms the existing algorithms with the accuracy percentage of 99%.

## 1. Introduction

Nonlinear dynamic systems, such as artificial neural networks (ANNs), have been developed as a result of the evolution of biological neural networks [1]. Artificial neural networks (ANNs) have been developed as a result of the evolution of biological neural networks [1]. Artificial neural networks (ANNs) have been widely used in a wide range of industries, including industrial output monitoring, environmental contamination prediction, and purification prediction. ANNs employ a variety of information processing techniques that are unique to them. It is one of the most frequently used neural network models when it comes to machine learning [2]. The low efficiency of this algorithm, as well as the delayed convergence time and tendency to slip into local minima, prevents it from being employed in many industries. Consider ant colony optimization when looking for an evolutionary algorithm that is capable of solving complex optimization problems with ease (ACO) [3]. The problem caused by the flaw in the neural network can be fixed with the help of ACO and other global optimization methods.

In recent years, there has been an increase in competitiveness in the fields of sports science and technology. The use of cutting-edge scientific training methods and equipment is required in order to increase one's athletic performance [4]. Sports is a great place to find scientific and technological developments since it brings people together. A single management system and movement mechanism are created under this ideology, which is centered on "revitalizing sports via science and education" [5]. Sports training and sports technology are combined into a single management system and movement mechanism under this philosophy. We are conducting this research because we feel that contemporary training requirements involve scientific investigation and public relations as well as the improvement of technical innovation, among other things [6, 7]. The study used physiological and biochemical data from national athletes to train the neural network, which was then combined with the ACO-BP algorithm to create a hybrid of the two systems [8]. To investigate the relationship between sports-related physiology and biochemistry and training load, the researchers employed an ant colony neural network prediction model. The ACO approach is used to optimize the weights of neural networks because the BP method might become stuck in a local optimum when applied to large datasets. In order to increase the performance of an ACO training network, it is necessary to use the better weight as the starting point for further optimization using the BP technique [9]. After conducting a thorough examination, Efat et al. came to the conclusion that the application of artificial intelligence and expert system design concepts could be beneficial to doctors in the future [10]. In a doctor's opinion, medical specialists' ways of thinking about diagnosis and treatment, as well as computer software, can help doctors deal with complicated medical situations.

In the field of medicine, artificial intelligence has made considerable strides in the last few years (AI). Computer and network science, as well as communication technologies and databases, are all covered in this textbook [11]. Since the beginning of modern medicine, the creation of medical expert systems has emerged as a major area of investigation. An artificial neural network- (ANN-) based multiprotocol recognition system is being developed. When normalizing frame head data, a specific length of data is used to compute the eigenvalue [12]. The conjugate gradient descent approach was used to simulate and compare multiple algorithms for the BP neural network identification algorithm, which was developed for the BP neural network [13]. A conclusion was reached on the basis of simulations and recognition rates, which indicated that BP neural networks might be employed for multiprotocol recognition with up to nine hidden layers. Multiprotocol identification systems take advantage of techniques such as developing an identification database in the system and detecting whether or not the data frame sent by the terminal address has been received before identification in order to improve real-time performance. The researchers devised a neural network compensator for this problem, which was based on the nonlinear error in motion control of the image-measuring device that they discovered. With the help of the servo motor's input and output data, it is possible to train simulation and compensation algorithms for nonlinear servo motors [14]. It is possible to increase the performance of the control system by using a high-precision neural network compensator for motion control placement [15]. The results of the simulation reveal that the controller is operational. The sophistication and capabilities of artificial neural network topologies have grown in recent years, as has their application. When it comes to engineering obstacles, traditional data processing methods are inadequate, and neural networks have been frequently used to address these difficulties [16]. Due to the advancements in neural network theory, as well as associated concepts and technologies, the breadth and depth of applications for artificial neural networks will continue to develop. When it comes to figuring out how good a teacher is, we use many different methods and techniques.

In China's large university system, there are millions of students enrolled. Is there a means to determine if a university's education is of the highest quality? The quality evaluation system in education is one of the most important parts of the educational process [17]. Several criteria can be used to assess the effectiveness of a professor's instruction, all of which are consistent with contemporary college and university standards. When it comes to judging the quality of university education, the current evaluation system has a number of flaws that must be addressed. The assessment index approach used in university physical education is needlessly difficult to understand. It is possible that a significant number of qualitative components in the teacher evaluation index will result in a nonlinear evaluation process. Building mathematical models that are as accurate as feasible begins with the establishment of a relationship between variables. When it comes to evaluating the quality of instruction, different techniques are used [18]. Instead, the evaluations are inconsistent since they are either excessively subjective or rely on simple mathematical operations (such as addition, subtraction, multiplication, and division) to determine the impact of teaching on student progress. Traditional methods make it difficult to conduct a thorough analysis of the outcomes of particular indicators. Since the algorithms cannot learn, it takes a long time to figure out how to fix the problem [19].

One of the most likely alternatives for achieving adaptive base isolation for civil construction is the laminated magnetorheological elastomer base isolator. However, using the device to achieve high-accuracy performance in structural control is a difficulty due to the intrinsic hysteretic and nonlinear behavior of magnetorheological elastomer base isolators. Finally, experimental data is used to confirm that the suggested artificial neural network-based approach is effective in producing accurate forecasts [20]. The comparison results of this study show that, while the BP neural network performs quite similarly to design codes in terms of performance, its accuracy is insufficient. The prediction of the BP neural network displays increased consistency with the actual measured values after the weights and thresholds were improved by $k$-fold cross-validation and GA. The study's findings can be used as a theoretical guide for the best-possible design of RC beams in real-world applications [21]. To decrease human-conducted onsite inspection tasks, a number of cutting-edge-automated inspection systems have been created employing these indicators. However, there is still room for improvement in terms of accuracy and computing cost in the efficiency of these strategies. In this paper, a deep convolutional neural network (DCNN) and an improved chicken swarm algorithm are used to construct a vision-based crack diagnostic approach (ECSA). Six convolutional layers, two pooling layers, and three fully linked layers make up the deep architecture of a DCNN model. ECSA is used to optimize the metaparameters of the DCNN model in order to increase the generalization capability of the trained model. Using picture patches that have been clipped from raw photographs of damaged concrete samples, the model is trained and tested. Finally, in order to assess the performance of the suggested method using a set of statistical evaluation indicators, a comparison analysis of various crack-detecting techniques is carried out [22, 23]. The goal of the study is to find out how the BP neural network model can be used to predict load in physical education teaching.

*1.1. Motivation of the Study.* Physical education is viewed as both an integral part of a health plan and an indicator of an educational system. This study suggested a novel method for instructing evaluation in higher education institutions'

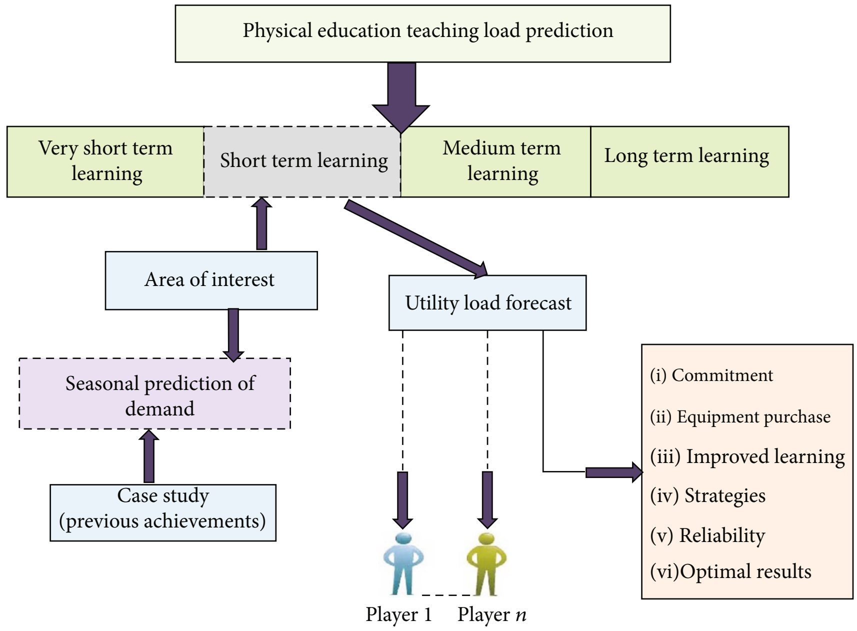


Figure 1: Proposed model for load prediction in physical education teaching.

student physical education classrooms. Through the integration of neural networks with BP neural network algorithms, the framework given by humans can increase the total conventional BP network's universal applicability as well as training time. A physical education teacher is in charge of instructing students in health and/or physical education. This study offered a fresh approach to teaching assessment in student physical education classes at higher education institutions. The framework provided by humans can boost the overall traditional BP network's wide applicability as well as training time by merging neural network with BP neural network approach.

## 2. Materials and Methods

Physical education is regarded as an essential component of a health plan, as well as a reflection of an education system. A physical education teacher is responsible for teaching student's physical education and/or health teaching. This investigation proposed a new technique to teaching evaluation through student physical education classes at higher education institutions. The framework humans suggested can enhance the overall conventional BP network's general applicability as well as training time through integrating neural network with BP neural network algorithm. Physical education is viewed as both an integral part of a health plan and an indicator of an educational system. The teaching of physical education and/or health to students is the responsibility of a physical education teacher. This study suggested a novel method for instructing evaluation in higher education institutions' student physical education classrooms. Through combining neural network with BP neural network method, the framework given by humans can increase the overall traditional BP network's general applicability as well as training time.

In the real-time education in the lower class, middle school, higher education, colleges, or education in the universities must involve physical education as one of the courses. Physical education is needed for students of an age group, as to monitor whether the student maintains the healthy life style. However, during certain complex environment, it will be highly difficult for the student and the faculty to continue the architecture. During the complex situations, certain students, or some persons, the options for choosing the course also differ based on the need, course schedule, completion of the course, and also, about the course duration. When the students are registering for the course, the student selects whether the student is in need of very short-term learning, short-term learning, medium-term learning, and long-term learning. In the first two options, the complete course will be handled by the coaches in a short span of time. It means the course has to be handled with a week or fortnight. In this scenario, the coach might have already be engaged with physical education for other students, and hence, the schedule of the coach has to be considered before schedule. The load of handling courses has to be analyzed and predicted using the back propagation neural network with genetic algorithm (BPNNGA). The students opting for short-term courses might be very specific in sports and could have been registered for physical education suitable for their area of interest. Additionally, depending on the natural annual season, the coach should be able to predict which sports have to be given preferences and proceed with the training of student (Figure 1).

It implies that the course must be completed in a week or two. In this case, the coach might already be involved in physical education for other children; therefore, scheduling must take the coach's schedule into account first. Back propagation neural network with genetic algorithm (BPNNGA) must be used to examine and forecast the load of handling courses. The students choosing short-term courses may have a very narrow focus on the sports and may have signed up for physical education classes that suited their interests. The coach should also be able to anticipate which sports has to be prioritized based on the natural annual season and continue with the student's training.

*2.1. Proposed Work.* The woman's processing elements are $x$ the analysis indicators of education physiological quality of education; the western surface nodes are $x$, as well as the output nodes $i$, which seems to be the analysis value of education physical quality education. Because the input image device broadcasts data directly to a center of the frame node, the output of the input layer node equals the input; the output information of a midlayer base station is the make significant contributions of an output nodes node, as well as the activation function only has one base station, that also receives the input of a middle layer node and produces an output the teaching standard evaluation effects as in Equation (1).

Input data node $m_i, i = \{1, 2,. \cdots, x\}$, where $x$ reflects teaching quality evaluation.

The input to the $H$ middle of the specimen node represents

$$H_j = \sum_{j=1}^{x} \varphi_{ij} m_i. \tag{1}$$

The $\varphi_{ij} m_i$ outcome is represented in

$$R_j = \sum_{j=1}^{x} \frac{1}{\left\{1 + \left[\left(\sum_{i=1}^{x} \varphi_j R_j\right)^{-1} - 1\right]^2\right\}'} = \sum_{j=1}^{x} \frac{1}{\left[\left(H_j^{-1} - 1\right)^2\right]}, \tag{2}$$

where $\varphi_j$ denotes the strength from of the input nodes base station $H_j^{-1}$ to a center of the frame node $j$ as well as $R_j$ denotes the graph's factor, the $i^{\text{th}}$ teaching performance assessment index.

Activation function node: there is only $S$ each node in the output nodes (shown in Equation (3)), as well as the information is the throughput of the center of the frame node:

$$S = \sum_{j=1}^{x} \frac{1}{\left\{1 + \left[\left(\sum_{i=1}^{x} \varphi_j R_j\right)^{-1} - 1\right]^2\right\}^{2'}}. \tag{3}$$

The $M$ average score of such sum of squares sum $\sum_{i=1}^{x} \varphi_j R_j$ of an error here between total performance as well as the measurement value of $G$ measurements is described as the learning optimization technique is shown in

$$G = \left(\frac{1}{M}\right) \sum_{m=1}^{m} [\bar{s} - s]^2 = \left(\frac{1}{M}\right) \sum_{m=1}^{m} G_j, \tag{4}$$

Despite the changing $\delta G$ framework of the BP neural network evaluation process, the purpose of network teaching seems to be to minimize $\tau$ by making adjustments of the network's login process. The training algorithm method $\delta c_{ij}$ is used to modify the delinking as continues to follow

$$G_{ij} = \sum \begin{cases} \varphi_{ij} = -\tau \left(\dfrac{\delta G}{\delta c_{ij}}\right), \\ \varphi_j = -\tau \left(\dfrac{\delta G}{\delta \varphi_{ij}}\right). \end{cases} \tag{5}$$

Moreover, for such learning rate, the $d_i \varphi_j R_j^2$ quantity of communication optimizing parameters between both the input data network as well as the midlayer access point is shown in

$$\varphi_{ij} = d_i \varphi_j R_j^2 \left[1 - \sum_{i=1}^{x} \varphi_{ij} d_j\right] \omega_j. \tag{6}$$

The quantity of connection optimizing parameters continues to follow

$$\varphi_j = \sum_{j=1}^{r} s^2 R_j \left[1 - \sum_{j=1}^{r} \varphi_j R_j\right] [\bar{s} - s]^2. \tag{7}$$

So, using this framework, the neural network's communication weight can indeed be defined to use the $\sum_{j=1}^{r} \varphi_j R_j$ optimization procedure of a specific neural network and also the inaccuracy between both the total performance as well as the different sampling value can indeed be reduced. System is higher optimization process using an optimized neural network shown in

$$\min(G) = \sum_{j=1}^{r} \int (\varphi_1, .. \cdots, \varphi_x), \tag{8}$$

in which $\min(G)$ is the overall inaccuracy of network training and $\varphi_1, .. \cdots, \varphi_x$ are the continuous weights after strong and united numbering that include the weights of the connections of input data access points as well as centre layer endpoints as well as the model parameters of center node and output node modules, as well as n represents the number of network parameters. Between many of them, $\bar{s}$ and $s$ are $\varphi_1$ variables that represent the minimum and maximum values of change.

In the process of analytical algorithms, the optimization algorithm is also a low capacity problem. Since an individual's areas selected are approximately equal to $\int(\varphi_1, .. \cdots, \varphi_x)$ ability, the description of an optimization process has a

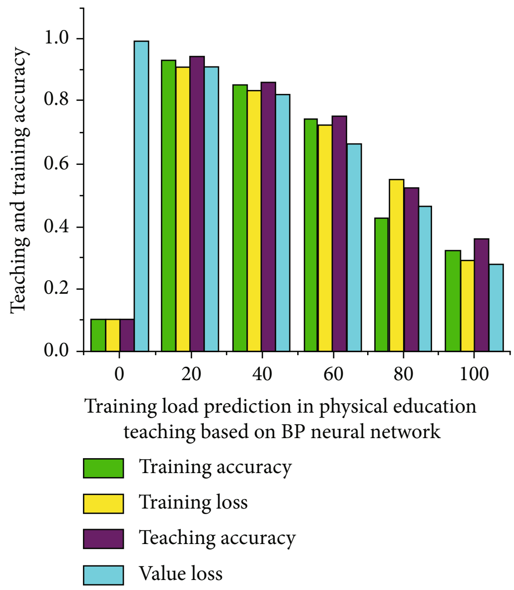


Figure 2: The training and testing graph of neural network accuracy and also loss using the genetic algorithm.

significant impact on genetic algorithms. Because there is a close navigation friendship between both $U - G$ the optimization process and the optimization method, the $G < U$ strength and conditioning computational method described in Equation (9) is used.

$$\int_i = \sum_{i=1} \begin{cases} U - G & G < U, \\ 0 & G \geq U, \end{cases} \tag{9}$$

in which $e$ denotes the training optimization problem as well as $G$ denotes the sum of all $G \geq U$ in the present generation. The following recommendations are used for the $M_r$ classification of genetic process parameter to accept responsibility for the $(\int_1 (U - G)/U) \in [0,0.5]$ efficiency of convergence as well as to minimize unnecessary integration engendered by efficient gene declassification:

$$M_r = \begin{cases} 2\left(\frac{\int_1 U - G\, G < U}{U}\right), & \frac{\int_1 (U - G)}{U} \in [0,0.5], \\ \left[1 - 2\left(1 - \left(\frac{\int_1 U - G\, G < U}{U}\right)^2\right)\right], & \frac{\int_1 (U - G)}{U} \in [0.5,1]. \end{cases} \tag{10}$$

The min and max technique is being used $(\int_1 (U - G)/U) \in [0.5,1]$ for normalization handling because it is a practical implementation for information processing that can effectively retain its own original definition while causing no data redundancy. The normalization equation to use in this document for such input information is as represented in Equation (10).

Standardization $(\int_1 (U - G)/U) \in [0.5,1]$ is the process of compressing a large range of information into the scope [0, 1] represented in

$$d' = \sum_{i=1}^{x} \frac{d - d_{\min}}{d_{\max} - d_{\min}}. \tag{11}$$

The standardization process $\sigma$ involves transforming the dataset's small and large outlier information through into normal random variable with an overall average value of 0 as well as a confidence interval of 1, following

$$d' = \sum_{i=1}^{x} \frac{d - \bar{d}_{\min}}{\sigma}. \tag{12}$$

Every base station is made up of three layers: the input nodes, the hidden nodes, and the convolution layers, with the weight lifting of the each layer being $\beta$, $\gamma$, and $\alpha$, including both. It implies that certain $\varphi_{y'y} q_{y'}^{t-1}$ documentation is retained in receptors after every cycle of data transmission in RNN. It needs to enter a $\varphi_y(q_{y'}^{t-1})$ next nerve cells as new knowledge and influences the successive data output. Equations (13) for the respective input nodes, the original input of the hidden units, and the output variable to of output nodes at time step $t$ are continued to Equation (14) and Equation (15).

$$\beta_y^t = \sum_{i=1}^{M} \varphi_{iy} d_i^t + \sum_{y'}^{M} \varphi_{y'y} q_{y'}^{t-1}, \tag{13}$$

$$\alpha_{y'}^{t-1} = \varphi_y\left(q_{y'}^{t-1}\right), \tag{14}$$

$$\gamma_{y'}^{t-1} = \sum_{y=1}^{M} \varphi_{y0} q_y^t. \tag{15}$$

## 3. Results and Discussion

The suggested model examines how students perceive physical education in online instruction, together with their capacity for knowledge and their usage of educational teaching systems in this context. Data was collected through an online survey with a relatively difficult set of questions from physical education teachers. The mean, standard deviation, difference of mean, and difference std are all specified in the performance analysis for unbiased evaluation of school teaching. These values serve as the basis for the examination of error difference values and the evaluation. The similarity of performance metrics with that of algorithms in Figure 2 also shows that such constructed model outperforms conventional algorithms, such as neural network models, in attempting to address human activity recognition problems.

The teaching accuracy rate of 97.35% also confirms its strong specificity. The possible explanation for this could be that just by trying to adjust the set of parameters; the convolutional neural network could also capture the qualities of training (92.76%) and teaching (94.34%) accuracy and loss of training (89%) analysis, optimize the required data, and enhance the consistency of human movement recognition.

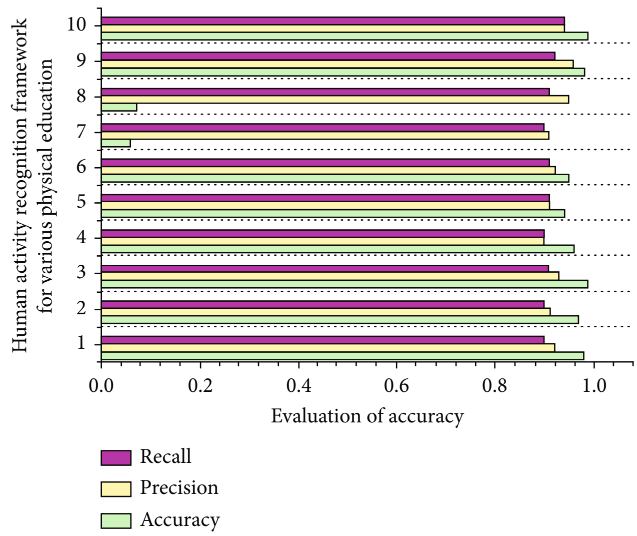


Figure 3: The outcomes of a human activity recognition framework for various physical education testing sets.

Table 1: Result analysis for various physical education testing sets.

| | Precision (%) | Recall (%) | Accuracy (%) |
|---|---|---|---|
| Various physical education | 0.89 | 0.87 | 0.99 |
| Human activity | 0.90 | 0.85 | 0.98 |

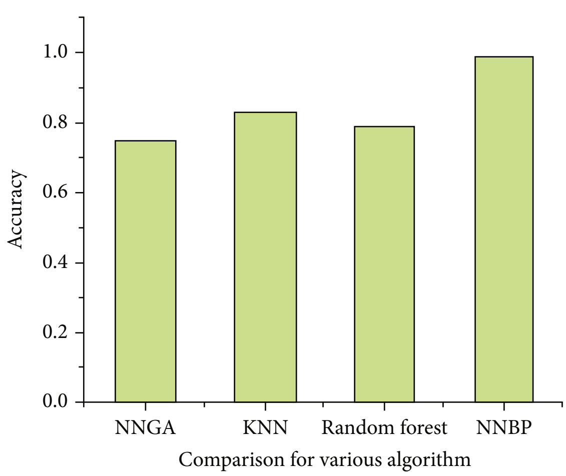


Figure 4: The neural network's human activity recognition accuracy using a BP algorithm is compared to a traditional algorithm.

The training and testing graph of neural network accuracy is load prediction in physical education teaching based on BP neural network.

Figure 3 shows also that trained human activity recognition framework seems to have an evaluation of overall accuracy of much more than 99.7%, a precision of much more than 92.46%, and a recall frequency of much more than 89.72%, for the various topics; since training, the human activity recognition framework for various physical education testing sets constructed in convolutional neural network model has outstanding human activity recognition possibility.

The separation of motion parameters also including higher levels of physical as well as posture recognition in the physical training teaching was shown to provide honest information of student movements for educators, and so, this appreciation of educational physical movements can also provide legitimate input to enhance training performance. Data from the sensors in sophisticated wearable technology was used to correctly determine human actions; however, the classification of structures is a contentious issue. The experimental results (refer to Table 1) demonstrate that such convolutional network-based human activity recognition system can accurately recognize human behavior with such an accuracy of much more than 98%. The result analyses for various physical education testing sets are for the precision (89%), recall (87%), and accuracy (99%) and then the human activity of precision (90%), recall (85%), and accuracy (98%).

The experimental results (refer to Figure 4) show that a convolutional neural network BP algorithm- (NNBP-) based human activity recognition method can effectively recognize human behavior with more than 99% accuracy. In a previous similar study, a human movement useful for detection with KNN features of regional succession set in place was discovered to have an 84% detection performance. An NNGA and random forest functionalized had a detection performance of 79%, outperforming the convolutional neural network GA with neural network BP algorithm (NNBP) efficiency of 95%.

It compares (refer to Table 2) for the analysis in the various algorithms is the best performance for the testing and training providing the high accuracy in NNBP (99%). Physical education is considered an essential component of the higher education teaching sector. An educator is responsible for teaching students teaching methods and (or) physical education. This study proposed a new technique for teaching analysis: physical education classes at academic institutions. The methodology which we suggested can enhance the overall traditional BP infrastructure in terms of global consolidation as well as training time besides combining neural network with BP algorithm (GA) (Figure 5).

The proposed model looks into the students regarding physical education in online teaching, with their ability to information, of their use of educational teaching systems inside this regard. A moderate set of questions was used to conduct an online survey from the physical education teaching provided the data. The performance analysis for impartial evaluation teaching of school specifies the mean, standard deviation, difference of mean, and difference std. Error difference values and analysis for the evaluation are based on these values. The inquiry into physical education teaching predicated on BP back propagation neural network focuses on deciding the best one to represent. Physical education teaching statistics compares the various methods of performance analysis for the median score is getting the best result for the NNBP.

Table 2: Comparison analysis for various algorithms.

| Algorithm | Training | Testing | Accuracy |
|---|---|---|---|
| NNGA | 0.79 | 0.73 | 0.75 |
| KNN | 0.83 | 0.89 | 0.83 |
| Random forest | 0.78 | 0.83 | 0.79 |
| NNBP | 0.99 | 0.98 | 0.99 |

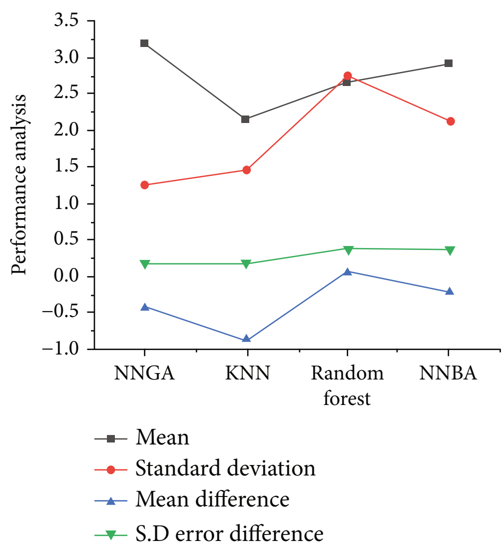


Figure 5: Performance analysis median scores as well as differences of physical education teaching statistics.

Table 3: Impartial measurement test of physical education teaching load prediction on BP neural network.

| Parameters | Mean | S. D. | Mean difference | Std. error difference |
|---|---|---|---|---|
| The online environment | 3.25 | 1.35 | -0.49 | 0.17 |
| Online-based teaching | 2.21 | 1.55 | -0.93 | 0.17 |
| Platform use | 2.83 | 2.89 | 0.07 | 0.38 |
| Platform usefulness | 2.96 | 2.21 | -0.31 | 0.38 |

Despite the challenges they encountered, students believe that the current face-to-face method is best able to handle the entire teaching-learning process. The platform should be seen as a supplement to facilitate the educational process. As a result, 68.32% of students will favor facial expression instruction. 62.27% would prefer a mix of offline and online classes, and 17.78% would recommend online-only instruction (Table 3).

The neural network with BP algorithm performs machine learning data analysis and extracts much more critical information from data by evaluating and modifying valuable data. Although data processing is usually more advanced or the level of available information is relatively large, machine learning models' difficulty is defining patterns from the data. Students say that learning is the primary goal, so education also involves guidelines, evolution, identification, knowledge, and teamwork, which all help students succeed. Students' performance structure achievement is based on behavioral quality evaluations. The accuracy of frequency-time(s) is based on the performance analysis and then compared to the various method and represented for the (Figure 6) differences in physical education teaching statistical data. From the above figure, it can be observed that the proposed back propagation neural network (NNBP) is able to achieve a minimum of 95% accuracy in teaching physical education.

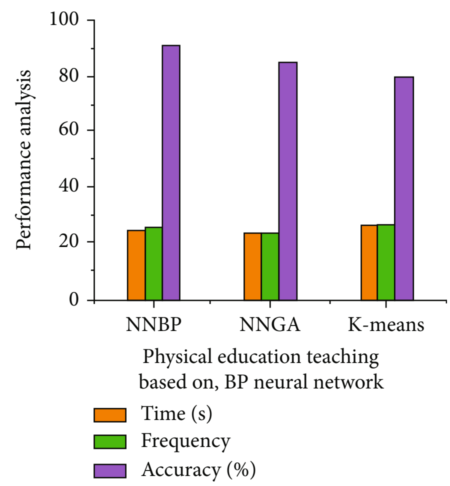


Figure 6: Comparison and performance analysis training load prediction in physical education teaching based on BP neural network statistics.

## 4. Conclusions

Physical education is viewed as both an integral part of a health plan and an indicator of an educational system. The teaching of physical education and/or health to students is the responsibility of a physical education teacher. This study focused on enhancing the load predicting in physical education using BP neural network. The importance of implementing genetic algorithm is to enhance the system convergence and obtain feasible results of BP algorithm. This study proposed neural network with the support of genetic algorithm for improving the optimization of BP neural network in load prediction. The study results proved that the algorithm attain an accuracy of 95%. With the help of optimized neural network connection weights, the evaluation of physical education teaching quality is recognized. For future study, it is highly recommended to implement IoT technology for analyzing the physical education quality.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The author declares that there are no conflicts of interest.

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