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Research Article

Implementation of Efficient Teaching Scheme of Human Anatomy and Physiology Based on Multimedia Information Processing Technologies

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An application scheme based on the teaching of human anatomy and physiology, namely, PBL, is proposed. In particular, 95 medical students were randomly divided into two groups: classes 2 and 3 were the experimental classes (48 students), and then, the teaching practice was carried out according to the machine learning route; year 1 and class 4 were the control classes (47 students), and the traditional teaching method was used. The teaching effectiveness was evaluated by performance analysis, the mean score of the overall evaluation of the experimental class was (93.23 ± 2.01), the mean score of the control group was (91.51 ± 2.89), and the difference was statistically significant ($p < 0.01$). The survey showed that more than 93% of the students in the experimental class thought that the deep learning model helped stimulate their interest in learning, enhance their sense of teamwork, and improve their overall ability.

1. Introduction

The ability to learn on their own is essential for medical students to advance their careers in later years [1]. With the continuous advancement of science and multimedia information processing technologies, the popularity of the internet and smart terminals has brought many innovative modes of independent learning to students [2]. The knowledge that medical students learn during their time at school is only the basis of their ability to become qualified doctors later in life and does not meet the demand for the knowledge needed to practice later in life. This requires that medical students have sufficient independent learning skills, and as teachers of human anatomy, they should also focus on developing their independent learning skills [3].

First, human anatomy, as the first professional foundation course for medical students entering medicine, involves many very specialized terms and is logically scattered, making it very difficult for students who are new to medicine [4]. Classroom time is limited, and even when teachers are teaching students in a constantly compressed anatomy, there is no way to interpret all the content, which may lead to students losing confidence in their studies due to difficulties in acquiring sufficient knowledge [5].

Second, the current teaching model in many medical schools is relatively traditional, with the teacher at the core forcibly instilling knowledge and students being forced to accept it, a situation that has yet to be fully reformed [6]. Teachers simply follow the content of the textbook and ignore the students' ability to comprehend it, resulting in a boring and rigid classroom atmosphere, which suppresses students' interest in learning, thus making students' learning effect poor [7].

In addition, the knowledge of human anatomy is complicated and numerous, and students are faced with a large number of terms that need to be memorized, which makes students gradually lose interest in the medical professional course, unable to grasp the theoretical knowledge well, and only in order to cope with the examination by rote memorization, which does not help the clinical laboratory operation of medical students [8]. Finally, some institutions lack specimens and remain to supply the laboratory class, usually many students around a dissection table to study, so that some students cannot observe and experience the wonders, and the theoretical knowledge learned cannot really be applied, which is also a more serious problem in the current teaching of human body science [9].

In today's society, technology is developing faster and faster, and the use of information technology is becoming more and more widespread, including the field of education [10]. Computer multimedia technology, as a product of this background environment, has a very important role in promoting the progress of teaching media and accelerating the formation of a multimedia teaching system [11]. It can foster students' independent learning in many ways, including teaching methods, content, and laws, thus making them increasingly motivated to learn. Human anatomy is one of the morphological disciplines, and in the past, teachers used to teach using board books or wall charts, which were inevitably abstract [12]. Nowadays, teachers can make use of multimedia technology in teaching human anatomy courses, which not only promotes good independent learning habits, but also stimulates students' interest in learning and puts them in a vivid, intuitive, and active teaching environment, thus contributing to a significant improvement in the quality of learning and classroom efficiency [13]. In addition, multimedia technology can extend the amount of resources available in the classroom, allowing students to access relevant materials via the internet to solve learning problems.

The establishment of a robust online resource base for human anatomy can provide more space for students to independently learn. For example, a number of courses related to human anatomy can be set up, and then, students can access teaching video materials, multimedia courseware materials, test banks, specimen image banks, reference materials, and other resources related to them from the campus network. At the same time, students and teachers and students and students can communicate with each other through WeChat and WeChat, thus giving students more independent learning mentality and spirit, which is conducive to their deeper exploration of human anatomy, from which they can find and solve problems in time, so that students' independent learning ability can be maximum [14].

2. Background Knowledge

2.1. Learning Concepts in Human Anatomy. Human anatomy is the basic science of the study of the form and structure of normal human parts and is a very important basic subject in medicine. Subjects such as pathology, physiology, and other clinical disciplines are all based on human anatomy. This is because the first prerequisite for medical students to enter medicine is to have an in-depth understanding of the normal structure of the human body so that they can correctly observe the physiological processes and pathological changes in the human body [15]. This allows for rational clinical care practices. In the process of learning human anatomy, students are bound to encounter many key points of difficulty, and the task of studying medicine is relatively heavy and relatively little time [16, 17]. Therefore, if medical students only learn human anatomy on the basis of classroom teaching by their teachers and lack the ability to independently learn, this will make the teaching efficiency of teachers and the quality of learning of students both lacking [18].

2.2. Theoretical Framework for Deep Learning. The deep learning route consists of the following components: designing learning objectives and learning content; preassessing learners; creating a positive learning culture; preparing and activating prior knowledge and acquiring new knowledge; processing knowledge in depth; and evaluating learners' learning, as shown in Figure 1.

Deep learning has become an important and effective learning style and learning concept in the context of the new era, attracting widespread attention from the learning research community and high attention from individual learners [19]. Human anatomy and physiology are important basic medical courses, which plays a pivotal role in the learning of students' professional knowledge and the cultivation of their professional qualities [20]. In this study, on the basis of elaborating the theoretical framework of deep learning, we construct a deep learning model suitable for human anatomy and physiology courses, highlight the main position of students in classroom teaching, improve their learning effect, cultivate their level and ability of reflection, and achieve better results.

The steps for optimizing the students' professional knowledge of assembled houses using the deep learning for the limit learning machine are as follows:

Step 1: we collect sample data of students' professional knowledge, divide them into training samples and validation samples, and form a sample matrix.

Step 2: we establish the limit learning machine network structure model and determine the parameters of the network model.

Step 3: we conduct random training to obtain the weights and hidden-layer node bias values, using the input weights and bias value range as the particle velocity and position-seeking range.

Step 4: we initialize various parameters in the deep learning model, such as the maximum number of iterations, population size, acceleration constant, inertia weight, and particle dimension.

Step 5: we combine the training samples to obtain the fitness of the particle and compare it with its own optimal fitness and the global optimal fitness to obtain

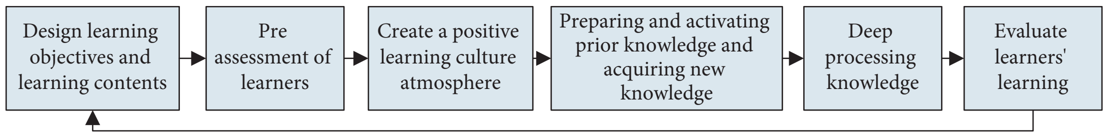

Figure 1: Deep learning route.

the individual optimal position and the global optimal position.

Step 6: we iterate and keep updating the velocity and position of the student weight until the stopping condition (maximum number of iterations or minimum fitness value) is met, is exit, and are decoded as the input weights and hidden-layer node bias values of the limit learning machine.

Step 7: We assign the output optimal parameters to the extreme learning machine prediction model, train the training samples with this model, and after training, input the validation sample data for prediction.

The model used in this study is based on GAN for optimization, which has opened up a new era of neural networks since Ian Goodfellow proposed GAN in 2014 [15].

The artificial neural network (ANN), referred to as a neural network (NN), is a mathematical model that mimics the behavioral characteristics of biological neural networks and processes data to achieve human artificial intelligence [16]. A neural network is shown in Figure 2 as a typical three-layer neural network framework, including an input layer, a hidden layer, an activation layer, an output layer, and a normalization process for the output.

The neural network graph has three neurons in the input layer and four neurons in the hidden layer. An activation function is added after the hidden layer to add a nonlinear factor to the results of the matrix operations, mapping the features to a high-dimensional nonlinear interval for interpretation. The output layer has two neurons, and the output of the output layer is normalized so that the data are restricted to a certain range, thus eliminating the undesirable effects caused by odd sample data [18].

The internal structure of the neural network is as follows: this structure is shown in Figure 3 as a processing unit of the neural network, x_i is the input from the ith neuron, w is the connection weight of the ith neuron, equivalent to the eigenvalue, the absolute value of the weight represents the size of the influence of the input signal on the neuron, θ_j is the bias also known as the threshold, after the activation function to obtain the output results, and the output results are shown in equation (1) [19].

$$y = f\left(\sum_{i=1}^{n} w_i x_i - \theta\right). \quad (1)$$

The GAN is primarily trained as a generator and a discriminator neural network, where the two networks are played to obtain a better result of the two networks. A high-performance discriminator is used for identification [20]. The input music, which may be generated by the generator,

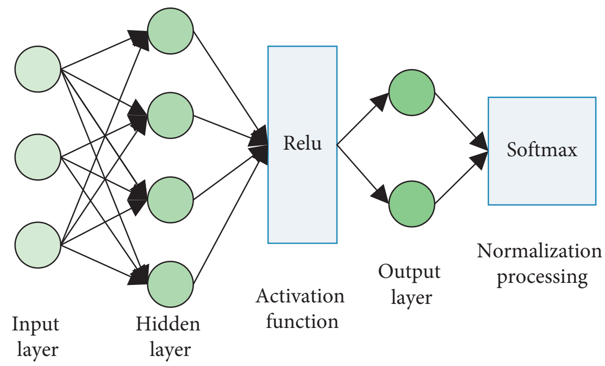

Figure 2: Neural network diagram.

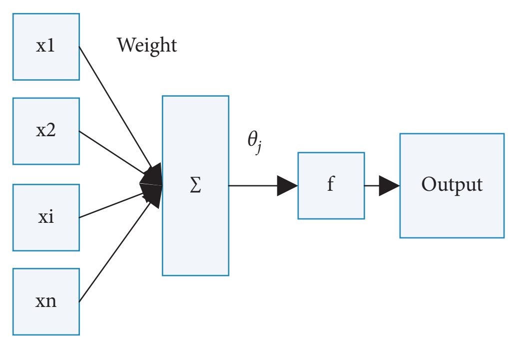

Figure 3: Diagram of the internal structure of the neural network.

is identified by the discriminator, and if it is real music, the identification result is true, and if it is generated music, the identification result is false, and the result of the identification by the discriminator gives a feedback to the generator to improve its performance in generating music, and the generator also gives a feedback to the discriminator to improve its performance in generating music [21]. The initial stage of the GAN network (as shown in Figure 4) is mainly used in image generation, in which the two networks play a game, each trying to beat the other to achieve its own performance improvement. The ultimate goal is to use the generator network to generate music melodies that can be faked.

3. PBL Teaching Methodology

The PBL is a complete approach to designing learning scenarios, which is problem-oriented and student-centered on a real-world basis, and has become a popular teaching method internationally. It combines theoretical knowledge with practical tasks or problems, enabling students to understand problems more visually and to solve them more skillfully.

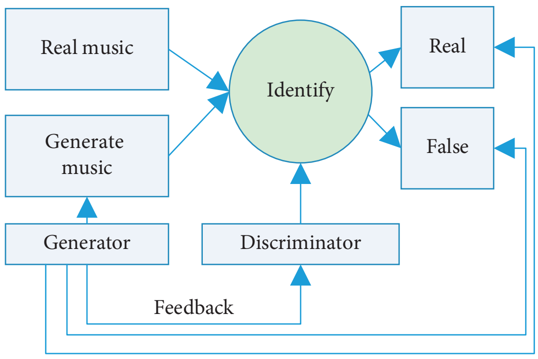

FIGURE 4: GAN network structure.

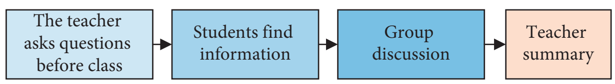

FIGURE 5: PBL teaching ideas' diagram.

In the course of teaching human anatomy, students are asked core questions about the chapters they are teaching; then, they are asked to solve the questions through discussions, library visits, and online research; and then, they are asked to explain the results of their research in class and the teacher analyses and comments on them. Students are then asked to explain their findings in class, and the teacher is expected to analyze and comment on them. This enables students to gain a firm grasp of their knowledge. As shown in Figure 5, that is, in the PBL teaching method, students actively participate in problem-solving ideas, which not only expands the breadth and depth of students' thinking, but also stimulates students' interest in learning, fully mobiles their enthusiasm for learning, and improves their independent learning ability. In addition, combining PBL with clinical practice can create a relaxed and lively learning atmosphere, allowing students to feel the good effects of independent learning, and then gain a sense of achievement from it, making students more confident to independently learn [21, 22].

In recent years, virtual simulation has been gradually applied to the teaching of basic medical courses. Human anatomy is the study of the normal human form and structure, and belongs to the category of morphology, which is one of the important basic courses in the medical profession. The circulatory system is an important chapter in human anatomy, and the structure of the heart is an essential knowledge for students to master [23–25].

In the AHP method, let the judgment matrix $\mathbf{B}_n$ is generated according to the small changes in the judgment matrix $\mathbf{B}_n^*$ in the ideal state, so the optimal value of $\mathbf{B}_n$ can be obtained through the set of weights in $\mathbf{B}_n^*$. We define the set of optimal weights as follows:

$\mathbf{W}_i^* = [\omega_1^*, \omega_2^*, \ldots, \omega_n^*]$; according to the principle of pairwise comparison, $a_{ij}^* \omega_j^* = \omega_i^*$, and it is possible to obtain

$$[a_{i1}^*, a_{i2}^*, \ldots, a_{in}^*] \times \mathbf{W}_n^* = n\omega_i^*. \quad (2)$$

That is,

$$\mathbf{B}_n^* \times \mathbf{W}_n^* = n\mathbf{W}_n^*. \quad (3)$$

According to the EM method, we can obtain the following:

$$\mathbf{B}_n \times \mathbf{W}_n = \beta_{\max} \mathbf{W}_n, \quad (4)$$

where $\beta_{\max}$ is defined as the maximum eigenvalue of the $\mathbf{B}_n$ matrix. When $\mathbf{B}_n$ is the optimal judgment matrix, $\beta_{\max} = n$, in other cases. The difference between $\beta_{\max} > n$. $\beta_{\max}$ and n represent the extent to which the judgment matrix $\mathbf{B}_n$ differs from the ideal state. Equations (3) and (4) give the following: $\mathbf{B}_n^* \mathbf{W}_n^* \leq \beta_{\max} \mathbf{W}_n^*$ Therefore, the weight interval estimation model can be obtained by converting it to a most-valued problem, i.e.,

$$s.t \begin{cases} [\min {}_{\omega}^{*}, \max \omega_i^*], \\ 0_n^* \mathbf{W}_n^* \leq \beta_{\max} \mathbf{W}_n^*, \\ 0 \leq \omega_i^* \leq 1, \qquad \omega_i^* = 1. \\ \qquad \sum_{i=1}^{n} \end{cases} \quad (5)$$

The MATLAB calculates the weight estimation model to obtain a range of subjective weights for each target attribute of the APH method, to determine the range for the random set in the self-learning process, and to further specify its weight value within the specified range of self-learning fluctuations [21].

4. Subjects and Research Methods

4.1. Study Subjects. A total of 95 students from our school were randomly divided into two groups by lottery, with an experimental class (48 students) and a control class (47 students). All the students in the two groups entered the school through the general entrance examination and were randomly divided into two classes, and there was no statistically significant difference between the two groups in terms of age, entrance score, and gender ($P < 0.01$).

4.2. Research Methodology. Both the control and the experimental classes practice teaching the section "the menstrual cycle and its regulation."

The teaching was carried out in an in-depth learning mode. Before the class, students are asked to familiarize themselves with the content of the textbook and make full use of relevant websites to gather information. Teachers provide students with teaching resources, including syllabus, videos, diagrams, case studies, and reference books. Teachers and students maintain effective communication using means of communication such as WeChat and WeChat, and teachers are always available to address difficulties encountered by students in their studies [26].

The teacher sets the level of mastery of morphology, from gross to microstructure, and physiology, in terms of the functional changes in the relevant organs, for example, mastering the morphology, location, and histological structure of the uterus and ovaries, familiarity with the concept of the menstrual cycle, and the pattern of changes in the endometrium during the menstrual cycle and the regulation of endocrine hormones during the menstrual cycle.

As students' basic knowledge varies, we assign a precourse quiz in the WeChat group—"Common Reproductive Diseases in Young People." This is a preassessment of students' learning based on their completion and the activity in the group, so that they can understand their basic knowledge. The quiz also allows students to check their own learning and to have a clear picture of what they are doing [27].

As students often log on to WeChat software, we use it to increase student engagement, create a positive learning culture, and create a good teacher-student relationship. Questions after watching the videos are discussed in the WeChat group and typical questions that cannot be solved, such as "what are the cyclical changes in the secretion of hormones by the ovaries, hypothalamus, and pituitary gland," are explained in class by the teacher.

The classroom is the place where students' knowledge is processed in depth, through collaborative classroom group learning and completion of assignments to achieve transfer and internalization of knowledge. In the classroom, the teacher summarizes and explains common problems based on students' learning, and then assigns a more complex assignment—"the relationship between the age distribution of lifestyle habits and economic factors"—which requires students to work in small groups to complete the assignment and have each group leader present their findings for the whole group, explaining the design ideas and the solution process. Students then interacted with each other, actively evaluating or making suggestions to the groups, while the teacher controlled the process and moderated the interaction. In the end, a summary and instructive evaluation of the groups' conclusions and performance of the learning activities are given.

As assessment and feedback often have a direct impact on learners' attitudes, approaches, and outcomes, it is important to measure whether students have achieved deep learning through appropriate assessment methods. In class, teachers provide timely assessment through group presentations and students and assess other groups through intergroup communication; after class, teachers assess students through WeChat group participation and examination tests to remind and encourage students to take an active role in their learning.

We used both questionnaires and comprehensive assessments to evaluate the effectiveness of the in-depth learning model in teaching human anatomy and physiology. 1. Satisfaction questionnaire: an anonymous questionnaire was administered to the experimental class. 2. Comprehensive assessment: due to the differences in assessment methods between the two groups of students, the "assessment scores" of the experimental class could not be used to compare with those of the control class, so we used a comprehensive assessment to form a score that could be used to evaluate the effectiveness of the teaching. This is calculated as follows: pretest grade (30%) + homework (20%) + general examination grade (50%).

The data were statistically analyzed using SPSS 19.0, and the measurement data were expressed as mean ± standard deviation ($\overline{x} \pm s$). The t-test was used for comparison between groups, and differences were considered statistically significant at $P < 0.05$.

5. Results

5.1. Results of the Survey on Students' Satisfaction with the Application of the Deep Learning Model in the Experimental Class. A total of 48 questionnaires were distributed, and 48 were returned, with a validity rate of 100%. The results show that the students in the experimental class generally like this new teaching mode and believe that it can improve their ability to independently learn and solve problems and enhance their sense of teamwork (see Table 1).

5.2. Comparison of Comprehensive Assessment Scores of Students in the Control Class of the Experimental Class. The mean score of the experimental class was higher than that of the control class in the section of "menstrual cycle and its regulation," and the difference was statistically significant ($P < 0.05$), as shown in Table 2.

5.3. Student Test Results. The results in Table 3 show the distribution of the theoretical, experimental, and overall scores of the two groups. The reason for the difference between the two groups may be that the integration of the human heart anatomy virtual simulation experiment into the teaching of circulatory system anatomy can promote students' motivation in both theory and laboratory classes and stimulate their intrinsic motivation.

6. Discussion

Human anatomy and physiology organically combine the morphological structure and functional activity patterns of the human body. It is a fundamental course for medical students to learn pharmacology, pathology, and other disciplines, and is also the key to learning professional courses. For many medical schools, human anatomy and physiology are not given enough attention by students due to the small number of class hours. In addition, traditional teaching methods tend to give a clear account of knowledge in a straightforward manner, taking the teacher to lecture and students to passively listen. Therefore, it has been a topic of continuous exploration for teachers to find out how to complete the teaching tasks within the limited class time and to achieve good teaching objectives.

In the practice of deep learning mode, we provide students with video learning materials partly in the online open educational resources to find their own teaching content of video resources as the course teaching content, not only to improve the utilization rate of resources, but also to save manpower and material resources; another part is the teacher's own production, according to the actual situation of students on the teaching content of the targeted explanation. The other part is produced by the teacher himself,

Table 1: Results of the survey on students' satisfaction with the application of the deep learning model in the experimental class.

Survey items	Satisfactory or relatively satisfactory rate (%)	Dissatisfaction rate (%)
The curriculum design is reasonable and meaningful	95.27	4.73
Stimulate learning interest, inspire thinking, and deepen understanding	93.16	6.84
Active classroom atmosphere and improve learning efficiency	94.96	5.04
Improve independent learning ability and problem-solving ability	97.31	2.87
Enhance the sense of teamwork	96.58	3.42
The teaching reform is appropriate and worth popularizing	95.02	4.98

Table 2: Comparison of the overall assessment scores of students in the control class of the experimental class ($\overline{x} \pm s$).

Group	Number of people	Examination results
Control group	48	93.23 ± 2.01
Experience group	47	91.51 ± 2.89
t value	—	3.358
P value	—	0.001

Table 3: Student test results (number of students).

Achievement	Grouping	Below 60 points	60–75 points	76–90 points	91–100 points	Total	X^2	P value
Theoretical achievements	Control group	10	62	56	4	132	11.35	0.001
	Experience group	2	45	67	10	124		
Experimental results	Control group	15	55	57	5	132	24.5	<0.001
	Experience group	1	33	76	14	124		
Total score	Control group	10	62	56	4	132	18.91	0.001
	Experience group	1	39	71	13	124		

according to the actual situation of the students to explain the teaching content, and according to the syllabus on certain key and difficult points to raise questions, so that students' learning objectives are relatively clear. Before and after the lesson, teachers and students use the internet and other means of communication to maintain effective communication and to exchange problems and difficulties encountered in learning at any time. Practice shows that deep learning requires teachers to teach not only what is known, but also to teach students to explore what is unknown and to empower them to answer unanswered questions and ask questions that have not yet been asked. Instead of mechanically recording the teacher's lectures or repeating exercises, deep learning allows students to collaborate with their peers to solve difficult problems in order to deepen their knowledge. We propose a basic process and a specific implementation approach based on the deep learning route, and innovate the teaching content, teaching methods and teaching processes through practical research, with a view to providing some references for further in-depth research on deep learning.

7. Conclusions

Morphological topics such as human anatomy require observation of the structures of the human body and require students to be able to observe laboratory specimens or models more and more closely in order to gain a deep understanding. In the traditional teaching model, the small number of laboratory specimens or models, the large number of students, and the limited learning time result in the teacher's inability to provide further individualized instruction to students, preventing some students from understanding the content well and in a timely manner. If they are in this state for a long time, students' motivation and ability to independently learn will be certainly affected to some extent. In addition to improving their own professional skills, teachers try more innovative teaching methods that take students as the main focus, cultivate their independent learning ability, stimulate their curiosity, and allow them to explore and understand human anatomy more deeply, thus laying a solid foundation for their future career development.

Data Availability

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

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this work.

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References

[1] A. Ghorbani, D. Ouyang, A. Abid et al., "Deep learning interpretation of echocardiograms," *NPJ digital medicine*, vol. 3, no. 1, p. 10, 2020.

[2] O. Faust, Y. Hagiwara, T. J. Hong, O. S. Lih, and U. R. Acharya, "Deep learning for healthcare applications based on physiological signals: a review," *Computer Methods and Programs in Biomedicine*, vol. 161, pp. 1–13, 2018.

[3] H. Che and J. Wang, "A nonnegative matrix factorization algorithm based on a discrete-time projection neural network," *Neural Networks*, vol. 103, pp. 63–71, 2018.

[4] H. Che and J. Wang, "A collaborative neurodynamic approach to global and combinatorial optimization," *Neural Networks*, vol. 114, pp. 15–27, 2019.

[5] R. Poplin, A. V. Varadarajan, K. Blumer et al., "Prediction of cardiovascular risk factors from retinal fundus photographs via deep learning," *Nature Biomedical Engineering*, vol. 2, no. 3, pp. 158–164, 2018.

[6] H. P. Martinez, Y. Bengio, and G. N. Yannakakis, "Learning deep physiological models of affect," *IEEE Computational Intelligence Magazine*, vol. 8, no. 2, pp. 20–33, 2013.

[7] B. A. Richards, T. P. Lillicrap, P. Beaudoin et al., "A deep learning framework for neuroscience," *Nature Neuroscience*, vol. 22, no. 11, pp. 1761–1770, 2019.

[8] D. Shen, G. Wu, and H.-I. Suk, "Deep learning in medical image analysis," *Annual Review of Biomedical Engineering*, vol. 19, no. 1, pp. 221–248, 2017.

[9] C. Xiao, E. Choi, and J. Sun, "Opportunities and challenges in developing deep learning models using electronic health records data: a systematic review," *Journal of the American Medical Informatics Association*, vol. 25, no. 10, pp. 1419–1428, 2018.

[10] Z. Akkus, A. Galimzianova, A. Hoogi, D. L. Rubin, and B. J. Erickson, "Deep learning for brain MRI segmentation: state of the art and future directions," *Journal of Digital Imaging*, vol. 30, no. 4, pp. 449–459, 2017.

[11] X. Huang, H. Jeon, J. Liu et al., "Deep-learning based label-free classification of activated and inactivated neutrophils for rapid immune state monitoring," *Sensors*, vol. 21, no. 2, p. 512, 2021.

[12] Y. Chen and Y. Xue, "A deep learning approach to human activity recognition based on single accelerometer," in *Proceedings of the 2015 IEEE international conference on systems, man, and cybernetics*, pp. 1488–1492, IEEE, Hong Kong, China, 2015 October.

[13] A. Brunetti, D. Buongiorno, G. F. Trotta, and V. Bevilacqua, "Computer vision and deep learning techniques for pedestrian detection and tracking: a survey," *Neurocomputing*, vol. 300, pp. 17–33, 2018.

[14] L. Sun, Y. Wang, Z. Qu, and N. N. Xiong, "BeatClass: a sustainable ecg classification system in IoT-based eHealth," *IEEE Internet of Things Journal*, vol. 9, no. 10, pp. 7178–7195, 2022.

[15] Y. Wang, L Sun, and S. Subramani, "Classifying arrhythmias based on imbalanced sensor data," *KSII Transactions on Internet & Information Systems. Jul.*vol. 15, no. 7, pp. p2304–2320, 2021.

[16] C. Cao, F. Liu, H. Tan et al., "Deep learning and its applications in biomedicine," *Genomics, Proteomics & Bioinformatics*, vol. 16, no. 1, pp. 17–32, 2018.

[17] S. Purushotham, C. Meng, Z. Che, and Y. Liu, "Benchmarking deep learning models on large healthcare datasets," *Journal of Biomedical Informatics*, vol. 83, pp. 112–134, 2018.

[18] A. Madani, R. Arnaout, M. Mofrad, and R. Arnaout, "Fast and accurate view classification of echocardiograms using deep learning," *NPJ digital medicine*, vol. 1, no. 1, pp. 1–8, 2018.

[19] M. Wainberg, D. Merico, A. Delong, and B. J. Frey, "Deep learning in biomedicine," *Nature Biotechnology*, vol. 36, no. 9, pp. 829–838, 2018.

[20] X. Ning, K. Gong, W. Li, and L. Zhang, "JWSAA: joint weak saliency and attention aware for person re-identification," *Neurocomputing*, vol. 453, pp. 801–811, 2021.

[21] X. Ning, P. Duan, W. Li, and S. Zhang, "Real-time 3D face alignment using an encoder-decoder network with an efficient deconvolution layer," *IEEE Signal Processing Letters*, vol. 27, pp. 1944–1948, 2020.

[22] Y. Xing, C. Lv, H. Wang, D. Cao, E. Velenis, and F.-Y. Wang, "Driver activity recognition for intelligent vehicles: a deep learning approach," *IEEE Transactions on Vehicular Technology*, vol. 68, no. 6, pp. 5379–5390, 2019.

[23] Z. H. A. N. G. Zhengwan, Z. H. A. N. G. Chunjiong, L. I. Hongbing, and X. I. E. Tao, "Multipath transmission selection algorithm based on immune connectivity model," *Journal of Computer Applications*, vol. 40, no. 12, p. 3571, 2020.

[24] A. Işın, C. Direkoğlu, and M. Şah, "Review of MRI-based brain tumor image segmentation using deep learning methods," *Procedia Computer Science*, vol. 102, pp. 317–324, 2016.

[25] M. Mahmud, M. S. Kaiser, A. Hussain, and S. Vassanelli, "Applications of deep learning and reinforcement learning to biological data," *IEEE Transactions on Neural Networks and Learning Systems*, vol. 29, no. 6, pp. 2063–2079, 2018.

[26] Y. Roy, H. Banville, I. Albuquerque, A. Gramfort, T. H. Falk, and J. Faubert, "Deep learning-based electroencephalography analysis: a systematic review," *Journal of Neural Engineering*, vol. 16, no. 5, Article ID 051001, 2019.

[27] A. Tavanaei, M. Ghodrati, S. R. Kheradpisheh, T. Masquelier, and A. Maida, "Deep learning in spiking neural networks," *Neural Networks*, vol. 111, pp. 47–63, 2019.