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THE INTEGRATION OF PERSONALIZED TRAINING PROGRAM DESIGN AND INFORMATION TECHNOLOGY FOR ATHLETES

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Abstract. In order to integrate the training of athletes with information technology, this paper proposes a method for evaluating the performance of athletes using training technology. HR, O2, and hemoglobin were selected as input vectors of SVM, and the corresponding values were used as outputs to generate the training model. Adjust the support vector machine to minimize measurement error based on the learning objective. Support vector machines are used to study training patterns and develop models to evaluate athletes' performance. College athletes were taken as research subjects and the effects of training were examined in five sports: football, basketball, basketball, swimming, and running. The results show that the relative error of this type is less than 1 when measuring the performance of various sports subjects; Relative errors in measuring the academic performance of athletes in various sports using physical fitness standards and sport-specific skills 1. The proposed model proves that the athlete's training index is incorrect and has a useful application.

Key words: Machine learning algorithms, Training effectiveness, Support Vector Machine, High dimensional feature space, Indicator matrix

1. Introduction. With the rapid development of information technology, its application in various fields is becoming increasingly widespread. In the field of sports training, the design of personalized training programs is crucial for the growth and development of athletes. Traditional training programs are often based on general templates and cannot meet the individual differences and special needs of each athlete. Therefore, how to integrate information technology with the design of personalized training programs for athletes has become a focus of current research. The application of information technology in the field of sports training has achieved significant results [1]. The design of personalized training programs for athletes needs to fully consider factors such as their physical condition, technical level, and training objectives, in order to develop the most suitable training plan for them. Traditional training program design is usually formulated by coaches based on experience and routines, but this approach cannot meet the unique needs of each athlete.

The application of information technology provides new possibilities for the design of personalized training programs. By utilizing sensors, monitoring devices, and data analysis techniques, real-time physical data and performance of athletes can be obtained. These data can help coaches more accurately evaluate the training effectiveness of athletes and adjust training plans in a timely manner. For example, sports tracking devices can record the athlete's movement trajectory and speed, heart rate monitoring devices can understand the athlete's physical condition, and strength testing devices can evaluate the athlete's muscle strength.

The analysis and integration of these data can provide targeted training suggestions for coaches, helping them develop personalized training plans. In addition, information technology can also provide online teaching platforms, allowing athletes to train anytime, anywhere. Through video teaching, virtual reality and other technological means, athletes can receive guidance and guidance from professional coaches to improve the effectiveness of training. This approach not only saves time and costs, but also breaks geographical restrictions, allowing more athletes to benefit from professional guidance [2].

In addition, information technology can also provide a platform for coaches and athletes to communicate and share. Through social media, online forums, and other channels, athletes can communicate with other

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athletes and coaches, share experiences and insights. This way of communication and sharing can stimulate innovation and cooperation, promote individual growth and team development of athletes. However, information technology also faces some challenges in the design of personalized training programs. Firstly, the accuracy and reliability of data are the core issues [3]. The body data of athletes needs to be collected through reliable sensors and devices, and the accuracy and stability of these devices have a significant impact on the credibility of the data. In addition, data analysis and processing require professional knowledge and technical support to ensure the extraction of useful information and guidance from massive amounts of data. Secondly, privacy and security issues also need to be taken seriously. The personal data involved in the design of personalized training programs needs to be legally and securely protected to avoid abuse or leakage. Relevant privacy policies and security measures need to be fully developed and implemented to safeguard the rights and interests of athletes and coaches.

In summary, the application of information technology in the field of sports training has brought new opportunities and challenges to the design of personalized training programs [4]. By using sensors, monitoring devices, and data analysis techniques, it is possible to more accurately evaluate the condition and training effectiveness of athletes, and develop personalized training plans for them. The establishment of online teaching platforms and communication sharing platforms also provides athletes with more learning and communication opportunities. However, data accuracy and privacy security issues need to be taken seriously and addressed. In the future, with the continuous development and innovation of information technology, the design of personalized training programs will be further improved, promoting the growth and development of athletes.

2. Analysis of the Application of Information Technology in Sports Training.

2.1. Information technology drives athlete selection through data-driven and evidence-based approaches. Scientific selection is based on the disciplines of life sciences such as biochemistry, biomechanics, and genetics, and utilizes modern scientific and technological means to comprehensively select athletes in terms of their physical form, physiological functions, physical fitness, psychological qualities, and sports skills according to their own characteristics and project characteristics [5]. It scientifically and reasonably selects outstanding athletes for high-level sports training. By combining modern information technology with biological data models, we aim to develop material selection criteria that are consistent with project characteristics, and strive to achieve rational, data-driven, and scientific material selection.

2.2. Information technology enables sports assistive devices to have intelligent brains. With the rapid development of modern science and technology such as electronic information technology, intelligent sensing technology, internet big data, cloud computing, artificial intelligence technology, etc., primitive traditional sports and fitness equipment that used to have no emotional color and no data feedback, such as barbells, treadmills, power extenders, etc., now have a "brain" that can interact and communicate with sports participants through the implantation of information technology, and automatic detection of physical fitness indicators functions such as automatic provision of training plans, real-time monitoring of exercise processes, and automatic feedback evaluation of exercise effects [6].

2.3. Information technology enhances the diversification of sports training forms and promotes scientific transformation. Information technology, as a product of technological development, has rapidly penetrated into people's daily work and life, and its impact is gradually expanding. The concept of the Technology Olympics not only increases people's expectations for modern sports events, but also makes them more visually appealing. The use of information technology for auxiliary training can make the training methods more scientific, diverse, and effective. In a sense, it is technology that makes sports more attractive, keeps sports up with the times, and makes sports more meaningful. Coaches use information processing technology to quickly and efficiently develop training plans, outlines, and lesson plans; Reasonably utilizing text processing technology, image editing technology, and video capture technology, the training content and methods are transmitted to the athlete's audio-visual system through technological means, improving the training experience in a new way, stimulating training motivation, and enhancing training effectiveness [7].

As one of the sports powerhouses, the United States has achieved impressive results in applying computer information processing technology to various fields of track and field training. For example, by loading a video into the system, the trajectory of the high jump athlete's movement before takeoff, the takeoff point, and various posture changes, angles, speeds, etc. of the body after takeoff are recorded [8]. These data are then compared with various data from world-renowned high jump athletes in the database to identify gaps, identify problems, and provide solutions. Through repeated recording and playback of technical movements, combined with simulation teaching of information technology, athletes can intuitively, three-dimensional, actively, and comprehensively master standardized and correct technical movements, thereby improving the scientific and effective nature of sports training, reducing the training cycle of athletes, improving the success rate, and effectively increasing the scientific output of sports results. The application of information technology can not only improve training effectiveness, enhance competitive level, refresh sports performance, but also reduce sports injuries and extend sports lifespan. Information technology has broken the traditional mode of sports competition and training. Traditional sports training requires coaches to conduct planned, purposeful, and organized speech and actions through language or physical means. However, various data during training often better illustrate the actual competition ability of athletes.

3. Evaluation of Athlete Training Effectiveness Based on Machine Learning Algorithms.

3.1. Machine learning algorithms. Let F (z) be a probability measure that exists in space z, with a set of functions Q(z,a) and $a \in \Lambda$, which can achieve the goal of minimizing the risk functional or machine learning. The formula is as follows:

$$R(a) = \int Q(z,a)dF(z) \tag{3.1}$$

In the formula, the probability measure F (z) is unknown, but there are fixed independent distribution samples.The formula for obtaining the loss function is as follows:

$$L(y, f(x,a)) = \begin{cases} 0, y = f(x,a) \\ 1, y \neq f(x,a) \end{cases} \tag{3.2}$$

Using the hazard function to justify the function f (x, a) and the probability of exit from the trainer, it is necessary to obtain the function with the minimum distribution error based on the knowledge configuration.

The support vector machine method finds the final model result with the best learning ability, low complexity and high generalizability based on limited sample data. Support vector machine has a high degree of generality, suitable for large-scale, small-sample and non-data fields. Choosing support vector machines as a way to measure sports performance can fully understand the advantages of support vector machines for processing small data. By obtaining the best surface distribution from a small sample size, the surface distribution obtained was the best, reducing the cost of sports performance analysis.

Use (x_i, y_i) to represent training data, and satisfy $i = 1, 2, ..., l, x \in R^d, y \in \{1, 1\}$, where l represents the number of samples. Assuming the existence of hyperplane H, there is the following formula:

$$w \cdot x + b = 0 \tag{3.3}$$

Using hyperplane H to separate positive and negative data, the hyperplane spacing formula is as follows:

$$\frac{2}{||w||} = d_1 + d_2 \tag{3.4}$$

In the formula, the euclidean norm of w and the two types of samples closest to H are represented by $||w||$ and d_1, d_2, respectively. Using support vector machine method to search for hyperplanes with the maximum interval, the expression is: $\underset{w.b.}{min} \frac{1}{2}||w||^2, s.t. y_i(x_i \cdot w + b) - 1 \geqslant 0$, in the formula, $i = 1, 2, ..., l$. The optimal classification surface problem is transformed into its dual problem through Lagrangian optimization method, and the formula obtained is as follows:

$$Q(\alpha) = \frac{1}{2} \sum_{i,j=1}^{l} \alpha_i \alpha_j y_i y_j (x_i \cdot x_j) - \sum_{i=1}^{l} \alpha_i \tag{3.5}$$

Using $\sum_{i=1}^{l} y_i\alpha_i$ and $\alpha_i \geqslant 0, i = 1, 2, ..., l.$ as constraints, use the Lagrange multiplier α_i corresponding to the sample to solve for the minimum value of Equation 3.5. The sample corresponding to α_i that is not 0 in the obtained result is the support vector[9].

The final optimal classification function is as follows:

$$f(x) = sgn\{(w \cdot x) + b\} = sgn\{\sum_{i=1}^{l} y_i\alpha_i(x_i \cdot x) + b*\} \tag{3.6}$$

In the formula, b* represents the classification threshold.

When the experimental sample is linearly inseparable, add a relaxation term; The method for obtaining $\xi_i \geqslant 0$ in Equations 3.5 and 3.6 is as follows:

$$\min_{w.b.} \frac{1}{2}||w||^2 + C\sum_{i=1}^{l} \xi_i, s.t.y_i(x_i \cdot w + b) - 1 + \xi_i \geqslant 0 \tag{3.7}$$

If the penalty factor $C > 0$ for the degree of punishment for correctly and wrongly divided samples is constant, then the dual problem condition is transformed into $0 \leqslant \alpha_i \leqslant C$.

The objective function obtained is as follows:

$$Q(\alpha) = \frac{1}{2}\sum_{i,j=1}^{l} \alpha_i\alpha_j y_i y_j K(x_i \cdot x_j) - \sum_{i=1}^{l} \alpha_i \tag{3.8}$$

At this point, the optimal classification function is as follows:

$$f(x) = sgn\{\sum_{i=1}^{l} y_i\alpha_i K(x_i \cdot x) + b*\} \tag{3.9}$$

Different types of nonlinear decision surface support vector machines can be implemented through differential kernel functions. The radial basis kernel function is selected as the kernel function for evaluating the training effectiveness of athletes, and its formula is as follows:

$$K(x_i \cdot x) = exp(-\frac{||x - x_i||^2}{2\sigma^2}) \tag{3.10}$$

3.2. Evaluation of Athlete Training Effectiveness. The physiological information during athlete training can reflect the training effect and showcase more information that the previous athlete training evaluation system could not evaluate.

Use $X = \{x_1, x_2, ..., x_n\}$ and $Y = \{y_1, y_2, ..., y_n\}$ to represent the athlete training sample set and the test indicator set that can reflect the physiological indicators of athlete training effectiveness, such as heart rate, oxygen uptake, hemoglobin, creatine kinase, etc. The matrix $A = (a_{ij})_{n\times m}$ represents the indicator matrix of the athlete training sample set X for the measurement indicator set Y, and the indicator values of the athlete training sample xi for the measurement indicator y_i are represented by $a_{ij} = y_j(x_i)(i = 1, 2, ...n; j = 1, 2, ..., m)$.

The input unit for evaluating athlete training effectiveness is the athlete training sample x_i, and the measurement vector $(r_{i1}, r_{i2}, ..., r_{im})$ under physiological measurement index y_j. If the evaluation result ui of athlete training effectiveness xi is used as the output unit, there exists a non-linear mapping between the normalization matrix R and the evaluation result, as shown in F, and its formula is as follows:

$$u_i = F(r_{ij}) \tag{3.11}$$

Select athlete training effect sample $x_i(r_{i1}, r_{i2}, ..., r_{im})$ as the input vector of the support vector machine, select training effect sample evaluation value as the regression target value U of the support vector machine, establish a learning sample set, represented by $G = \{(x_i, u_i)\}_i^n$, and obtain the regression function as follows:

$$u = \sum_{k=1}^{s} (\alpha_k - \alpha_k*)K(x, x^k) + b \tag{3.12}$$

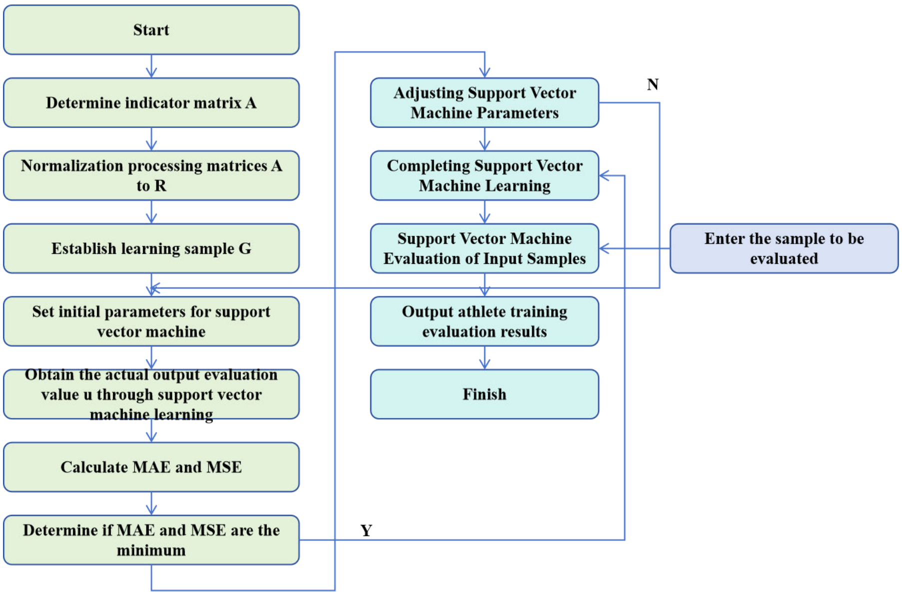


Fig. 3.1: Structural diagram of athlete training effect assessment

In the formula, X^k and s represent support vectors and the number of support vectors, respectively, $x^k = (r_{k1}, r_{k2}, ..., r_{km}), k = 1, 2, ..., s$.

Implement athlete training sample xi through the above process; The non-linear mapping F between the measurement vector $(r_{i1}, r_{i2}, ..., r_{im})$ of physiological indicators y_j and the evaluation value u_i of training effectiveness[10].

The structure diagram of evaluating athlete training effectiveness using the support vector machine method in machine learning algorithms is shown in Figure 3.1.

The process of evaluating the effectiveness of athlete training is as follows:

1. Determine the evaluation index matrix A for athlete training effectiveness based on physiological indicators that affect athlete training effectiveness;
2. Convert the indicator matrix A for evaluating the training effectiveness of athletes to a normalized matrix R;
3. Establish a learning sample set $G = \{(x_i, u_i)\}$ using athlete training effect sample $x_i = (r_{i1}, r_{i2}, ..., r_{im})$ and evaluation value ui, and randomly select samples from the learning sample set to establish a training and validation set for support vector machine learning.
4. Select the radial basis kernel function as the support vector machine kernel function to obtain the regression function formula. The criteria for selecting parameters for evaluating the training effectiveness of athletes are as follows:

$$\begin{cases} MAE = \frac{1}{l}\sum_{i=1}^{l} |u_p^i - u_{SVM}^i| \\ MSE = \frac{1}{l}\sum_{i=1}^{l} (u_p^i - u_{SVM}^i)^2 \end{cases} \tag{3.13}$$

   In the formula, MAE and MSE represent the average absolute error and mean square error of the validation samples, u_p^l and u_{SVM}^l represent the expert evaluation value and support vector machine calculation value of the validation samples, and l represents the total number of samples to be evaluated.
5. On this basis, SVM is used to evaluate the training results.By inputting the physiological testing indicator vector $(r_{i1}, r_{i2}, ..., r_{im})$ of the training effect sample x_i of the athlete to be evaluated, the final support vector machine's athlete training effect evaluation result u_{SVM}^i can be obtained.

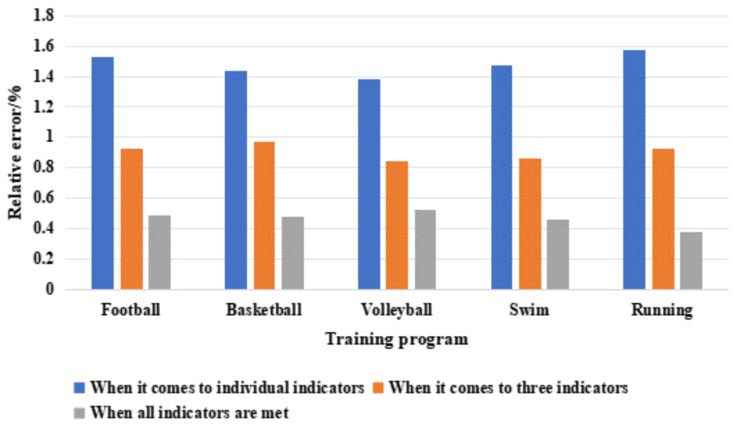


Fig. 4.1: Relative error in the number of different indicators

4. Example Analysis. Ten athletes majoring in sports training from a certain sports university were selected as the research subjects, and they were trained in five sports: football, basketball, volleyball, swimming, and running. This method was used to evaluate the training effects of the ten athletes. Heart rate and lung capacity were collected before and after each exercise training, and morning venous blood was collected for the training cycle.

Out of a total of 10,000 samples collected, 2,000 were used as research samples and the remaining 8,000 were used as test samples. Select radial root kernel function as support vector machine kernel function, use winSVM software to solve support vector machine problem, this software is optimized for Windows operating system, fully support vector machine classification and regression problem.

The training samples are divided into 10 groups of 200 each, and finally the parameters of the support vector machine are determined as C=150, $\sigma^2 = 0.016$, and the final decision is used to train the support vector to carry the vector and get the number of support vectors and the parameter b. 30 and -0.228 for the regression function [11]. To assess sports performance, heart rate, maximal oxygen uptake, hemoglobin, creatine kinase, and blood lactate are selected as physical parameters. This method was used to estimate the relative error of measuring the academic performance of athletes in various sports when only heart rate, heart rate, maximal oxygen uptake, and hemoglobin were used as measures of physical fitness five physical parameters used. From the experiments in Figure 4.1, it can be seen that as the number of physical parameters increases, the relative error of sports evaluation results decreases. This suggests that adding more physical parameters to the machine learning algorithm can improve the accuracy of sports analysis. The main reason is that many physical parameters improve the various results of sports analysis and improve the accuracy of sports analysis [12,13,14,15].

The output results of evaluating the training effects of 5 sports for 10 athletes using this method are shown in Figure 4.2.

Based on the evaluation of sports training results shown in Figure 4.2, the results of expert evaluation were selected as the correct decision criteria for sports performance evaluation, and five types of sports were analyzed in this type of performance analysis: football, basketball, and basketball. swimming and archery. To justify this type of performance assessment, physical activity and sport-specific skills were chosen as the model for comparison. Figure 4 shows a comparison of the relative errors in measuring the fitness index of athletes in five sports using different models[16,17,18,19]. From the comparison results in Figure 4.3(a)-(e), it can be seen that when selecting the expert evaluation the basis of performance evaluation, the relative error of this type is less than 1 when evaluating the training of athletes of various sports; Relative errors in measuring academic performance of athletes in various sports using fitness standards and sport-specific skills 1. Comparison of the results shows that this type has a good performance in sports evaluation. Analyzing the results of this type

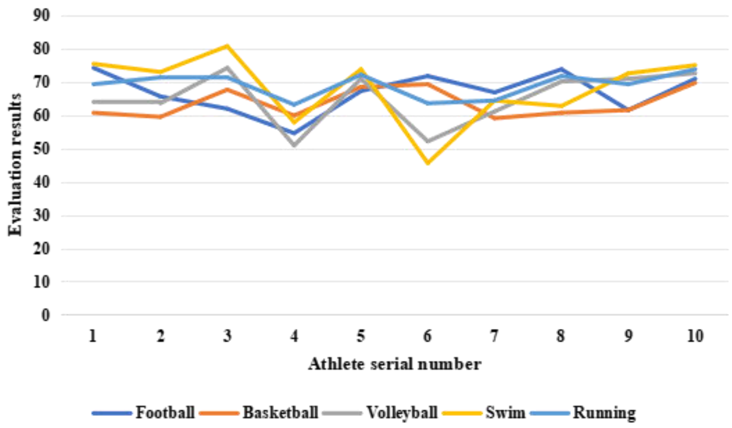


Fig. 4.2: Results of the training effect evaluation of the athletes

of measurement can help coaches develop training plans for soccer performance. This type can be used to objectively evaluate soccer performance.

5. Conclusion. The training effect of athletes determines their final competitive performance, which is influenced by factors such as training methods and personal qualities, resulting in a wide range of fluctuations in athlete performance. Evaluate the training effectiveness of athletes using physiological indicators, and achieve the evaluation of athlete training effectiveness through the support vector machine method with higher evaluation performance in machine learning algorithms. Support vector machines have high learning and generalization abilities, the effectiveness of using the proposed method to evaluate the athletic performance of athletes through sports such as football has high guiding significance for improving the training effectiveness of athletes.

REFERENCES

[1] Li, X. (2022). Design of industrial logistics information integration method based on supply chain management. International Journal of Manufacturing Technology and Management, 39(3), 511-534.

[2] Zhang, Y. (2023). Construction of accounting information system specialized creative integration course based on "financial sharing". Curriculum and Teaching Methodology, 78(4), 4767-4785.

[3] Dong-Bo, W. (2021). Investigation and design of information science education system and talent training. Information Studies:Theory & Application, 44(1), 0-0.

[4] Vandette, M. P., Jones, G., Gosselin, J., & Kogan, C. S. (2021). The role of the supervisory working alliance in experiential supervision-of-supervision training: a mixed design and multiple perspective study. Journal of psychotherapy integration,85(4), 31.

[5] Cheng, Y., Zhao, X., Wu, J., Liu, H., Zhao, Y., & Shurafa, M. A., et al. (2021). Research on the smart medical system based on nb-iot technology. Mobile Information Systems, 11(1), 116.

[6] Zhao, H., Yang, Z., Chen, C., Liu, Z., & Qi, B. (2023). Optimal design of ladder-stress accelerated degradation test plan for motorized spindle in non-cube test area. The International Journal of Advanced Manufacturing Technology, 10(3), 1-34.

[7] Zhang, Z., & Jia, L. (2023). Optimal multiobjective design of guidance information systems in underground spaces: model development and a transportation hub case study. Tunnelling and Underground Space Technology, 134(7), 105007.

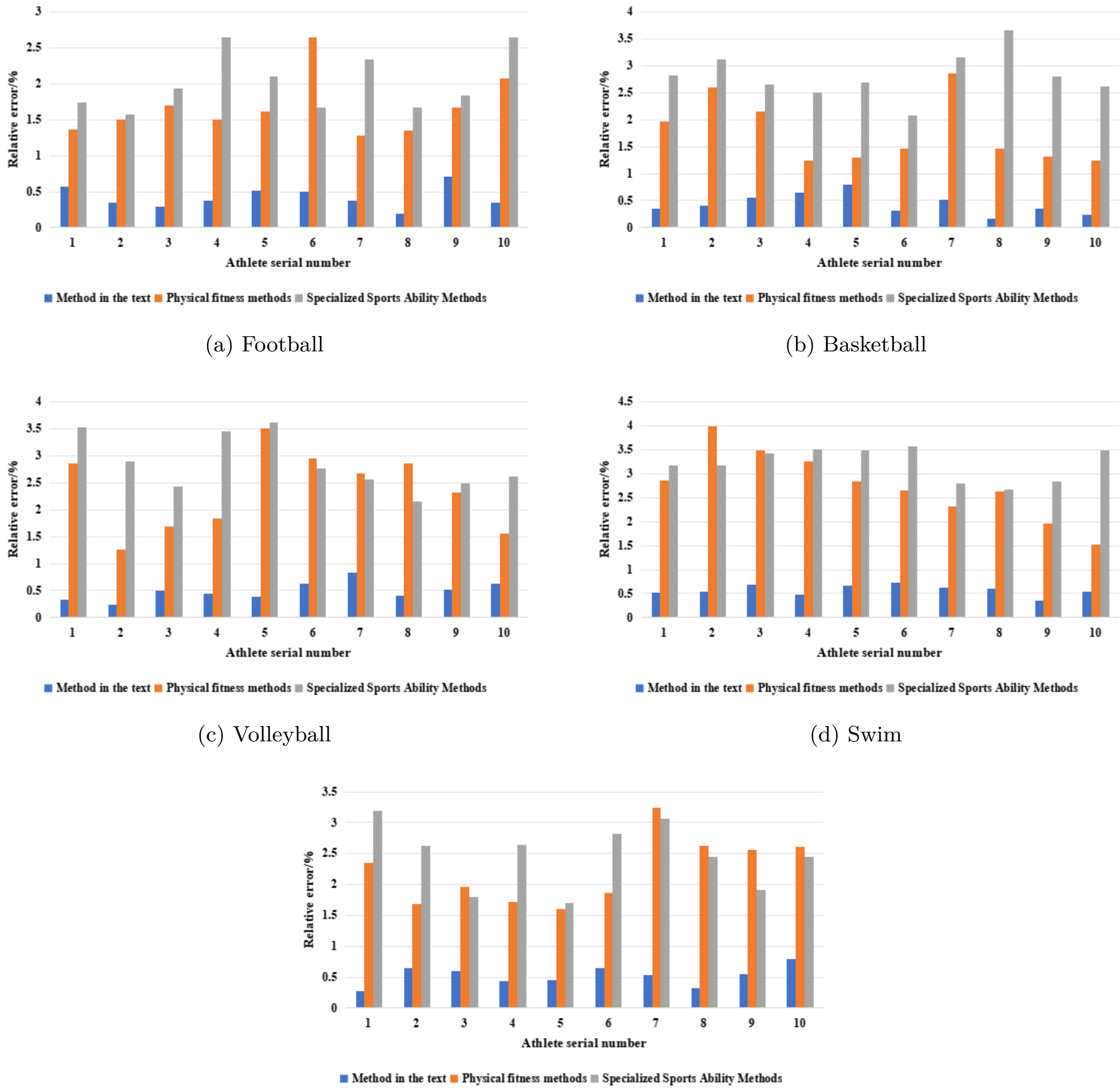
[8] Joshy, C. G., Elavarasan, K., & Zynudheen, A. A. (2021). Design and development of web based information system for value added fish by-products. Fishery Technology,85(1), 58.

[9] Wang, Z. (2021). Evaluation model of parking equipment planning and design based on object-oriented technology. Applied Sciences, 11(3),74-78.

[10] Shin, Y. J. (2021). The improvement plan for personal information protection for artificial intelligence(ai) service in south korea. Journal of Convergence Information Technology, 11(2), 20-33.

[11] Tariku, N., & Lessa, L. (2021). Towards a conceptual framework for information technology disaster recovery plan for banks: based on cases from ethiopia. International Journal of Computer Applications, 49(4), 314-325.

[12] Tang, Y., Song, M., Xiao, S., Liu, X., & Liang, G. (2021). Cax integration and its design application based on feature extension of sensor components. Hindawi Limited.



(a) Football (b) Basketball

(c) Volleyball (d) Swim

(e) Running

Fig. 4.3: Relative errors were assessed for different exercise items

[13] Embuldeniya, R., & Merabet, A. (2023). Design, modelling and simulation of hybrid vibration energy harvesting system using integration of piezoelectricity and electromagnetism. Renewable Energy and Power Quality Journal.
[14] Sasatake, H., Tasaki, R., Yamashita, T., & Uchiyama, N. (2021). Imitation learning system design with small training data for flexible tool manipulation. International journal of automation technology(5), 15.
[15] Liu, Y., Wu, H., Lv, H., & Wu, X. (2021). Strategic integration of moo2 onto mn0.5cd0.5s/cu2o p-n junction: rational design with efficient charge transfer for boosting photocatalytic hydrogen production. Powder Technology: An International Journal on the Science and Technology of Wet and Dry Particulate Systems,74(394), 394.
[16] Xu, Z., & Zhou, W. (2021). A data technology oriented to information fusion to build an intelligent accounting computerized model. Scientific programming,857(Pt.12), 2021.
[17] Abdurahimovna, U. F. (2021). Methodology of training students in design and modeling of clothes using information com-

munication technologies. Revista Gesto Inovao e Tecnologias, 19(5), 416-424.
[18] Zhigunova, A. (2021). Integration of students' academic and extracurricular activities by creating conditions for business-oriented design and practical activities at the university. Standards and Monitoring in Education,32(7), 21-25.
[19] Samandari, H., Khave, L. J., Janani, M., Farazmand, S., Motafavi, S. S., & Gholami, J., et al. (2022). Evaluation of a training program in general practitioners' attitude toward the integration of substance use disorders services in primary health care. Iranian Journal of Psychiatry and Behavioral Sciences, 37(5), 813-830.

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