Hindawi
Mobile Information Systems
Volume 2022, Article ID 2003301, 11 pages
https://doi.org/10.1155/2022/2003301

*Research Article*

# Computer Simulation Algorithm of Team Gymnastics Formation Change Path under Artificial Intelligence and Network Big Data

**Anfeng Zhu[1] and Liangliang Cheng[2]**

[1]*Guangzhou Sontan Polytechnic College, Guangzhou 511370, Guangdong, China*
[2]*Ministry of Sports, Chongqing University of Science and Technology, Chongqing 401331, China*

Correspondence should be addressed to Liangliang Cheng; 2013927@cqust.edu.cn

Received 25 February 2022; Revised 23 April 2022; Accepted 5 May 2022; Published 31 May 2022

Academic Editor: Chia-Huei Wu



With the development of economy, all world countries are entering the ranks of competitive sports. The Olympic Games or large-scale gymnastics performances are of great significance to the publicity and implementation of the national health plan. This paper aims to study the computer simulation algorithm of group gymnastics formation change path under artificial intelligence and network big data, so as to find out the path change algorithm of each team member, so that members in group gymnastics can clearly see their own moving route, and finally achieve the purpose of reducing the difficulty and cost of rehearsal. In this paper, the ellipse search algorithm and the traditional *Dijkstra* algorithm, the rectangle search algorithm, and the traditional *Dijkstra* algorithm are deeply compared and analyzed, and then, the experimental comparison between the ellipse search algorithm and the rectangle search algorithm is carried out. It is concluded that when finding the shortest path and when the straight-line distance between two nodes is 4.0 km, the time used by the rectangle search algorithm is 2.1 s, while the ellipse search algorithm needs 3.98 s. This shows that the rectangle search algorithm greatly saves the operation time and has superior performance.

## 1. Introduction

Group gymnastics is not only a large-scale celebration in life but also a wonderful content that cannot be ignored in the opening ceremony of the school sports meeting or in the Olympic Games of various countries. Chinese gymnastics has outstanding achievements in front of the people of the world and amazes people from all over the world. Behind a wonderful performance is the sweat of all the performers. Similarly, the successful interpretation of group gymnastics is inseparable from the efforts of performers, planners, organizational managers, scholars, and group gymnastics experts. It is precisely because China's group gymnastics have achieved enviable results. This is not only an artistic interpretation but also an interpretation of a national spirit. Unity, wisdom, courage, and innovation are the spiritual support for the success of group gymnastics. With the progress of society and the prosperity of the economy, most people no longer worry about food and clothing, but have higher requirements for life. As countries around the world call on people to keep fit, people are aware of the importance of health. It is for this reason that the related research on enriching the theory of group gymnastics has also attracted people's attention.

Through relevant background investigations, the practice of group gymnastics has aroused good responses in various countries. But because of this, many scholars have ignored the theoretical research of group gymnastics. It is more about how group gymnastics can interpret better artistic effects, including background design, content presentation, and spiritual manifestation. However, no specific research has been made on any of these details. Therefore, the reader is more aware of related concepts and basic guidance, and cannot obtain detailed references. There are not many studies on the path algorithm of group gymnastics formation change. In this paper, under the environment of artificial intelligence and network big data, the computer simulation algorithm of group gymnastics formation transformation path is explored, so as to provide a better reference for the practice of group gymnastics.

In recent years, the performance of group gymnastics has achieved good results. Therefore, scholars have not paid much attention to the theoretical research of group gymnastics, and it only talks about the advantages of artificial intelligence and big data-related technologies in group gymnastics from the side, but lacks specific conceptual research. Therefore, this paper explores the computer simulation algorithm of group gymnastics formation transformation path under artificial intelligence and network big data, so as to further promote the development of artificial intelligence and network big data and also provide reference for future theoretical research on group gymnastics.

## 2. Related Work

The Internet of Things has huge market potential, and the growth rate has been increasing in recent years. As one of the important technologies in recent years, the Internet of Things has attracted the attention of many scholars. The accumulation of massive data in cheminformatics databases makes the role of big data and artificial intelligence (AI) indispensable in drug design. In this era of big data, new algorithms and architectures need to be developed to mine these databases and meet the specific needs of various drug discovery processes, such as virtual drug screening and de novo molecular design. Tripathi et al. summarized the role of big data and artificial intelligence technologies currently being applied to meet the growing research needs in the drug discovery pipeline [1]. The combination of big data and artificial intelligence (AI) is increasingly impacting the field of electrophysiology, creating algorithms to improve automated diagnosis of clinical ECG or ambulatory heart rhythm devices. Leur et al. described the opportunities and threats of artificial intelligence in electrophysiology, focusing on the electrocardiogram. It further guides clinicians to evaluate new AI electrophysiological applications before clinical implementation [2]. Artificial intelligence has revolutionized the drug development process, enabling the rapid identification of potentially bioactive compounds from millions of drug candidates in a short period of time. Nayarisseri et al. provided a comprehensive overview of some applications of the tools of machine learning and concluded that in the era of big data, machine learning methods have developed into a powerful and effective method to deal with the large amount of data generated by modern drug discovery [3]. Recently, big data and artificial intelligence (AI) based on communication systems have become one of the hottest issues in the technology field, and methods to analyze big data using artificial intelligence methods are now considered essential. Jeong and Park involved topics in different research fields, provided different paradigms, and provided new ideas and directions for artificial intelligence research [4]. The implementation of artificial intelligence (AI) in a smart society, where analysis of human habits is mandatory, requires automated data scheduling and analysis using smart applications, smart infrastructure, smart systems, and smart networks. Against this backdrop of a large gap between training and operational processes, DR proposes near-zero fault advanced diagnostics (AD) for intelligent management to close this gap, demonstrating that it can be exploited in any context of society 5.0 to reduce risk factors at all management levels and ensure quality and sustainability [5]. In this digital age, humanity has greatly increased its reliance on technology in various fields. With the advancement of Internet technology, cybersecurity of software and hardware systems is now a prerequisite for major business operations. A deep learning method for detecting IOT network attacks using long-term and short-term network classifiers is introduced. Experimental tests show a precision of 99.09%, an F1 score of 99.46%, and a recall of 99.51%. The ability of this method to detect network attacks is excellent [6]. To sum up, artificial intelligence and network big data have been applied to various fields, including drug discovery and IOT security. With the development of big data and artificial intelligence technology, group gymnastics has not received more attention. Therefore, how to make better use of science and technology to promote the development of group gymnastics is what many scholars need to pay attention to at present, and more explorations need to be carried out in depth.

## 3. Relevant Research Theory of Computer Simulation Algorithm for Group Gymnastics Formation Transformation Path under Artificial Intelligence and Network Big Data

*3.1. The Relationship between Artificial Intelligence and Network Big Data.* With the advent of the information age, intelligence and informatization have become an inseparable part of people's lives. In recent years, big data, artificial intelligence, and the Internet of Things have entered daily life with the era of the Internet, including smart furniture, smart buildings, robots, and smart toys. Intelligence and informatization complement each other. With the advent of the age of intelligence, complex and meaningless human labor will be replaced by machines, and human beings will further develop to a higher level. In the era of big data, intelligence is a significant feature of informatization [7]. Humanity will also enter the era of intelligence. Artificial intelligence and big data have brought convenience to people's lives and brought high efficiency to people's work, but also quickly joined the competition of group gymnastics formations. Using intelligent technology is to provide new methods and tools for group gymnastics formation change path, drive the implementation of more efficient computer simulation algorithms, and promote the high-level and precise transformation of group gymnastics [8].

With the rapid development and progress of science and technology, Internet informatization plays an increasingly significant role in human social life, and Internet technology has penetrated into all walks of life, promoting the arrival of the era of big data. In the era of big data, data have become the core element of the network. The Internet of Things and artificial intelligence technology are two crucial modern technologies in the era of big data, which make people' s production and life more convenient, efficient, and intelligent. When the world enters the era of big data, society will experience similar crustal movements. Indeed, the era of big data has completed a series of data-centered technological changes in concepts, technologies, and applications. Such extensive and fundamental changes will inevitably lead to changes in human production and communication methods, and changes in social management methods and structures, and will also call for the corresponding reform of the computer simulation algorithm of group gymnastics formation transformation path [9, 10].

The data used by the Internet of Things generate big data through automatic perception and collection, which cannot be analyzed and processed manually by traditional data analysis methods. The way to make IOT data analysis and processing more intelligent is to apply artificial intelligence to it [11, 12]. Artificial intelligence equipment and products will be more and more developed and applied. The addition of the Internet of Things technology solves the problems of data transmission, data collection, data processing, and information transmission and forms a good chain reaction between information input, conversion, and transmission, which provides good automation and intelligence, foundation, and support.

*3.2. Team Gymnastics.* Group gymnastics, as the name suggests, is a collective performance project and a sports performance art. Group gymnastics is performed on the playground by dozens, hundreds, or even thousands of performers. Group gymnastics is not an individual performance, and a successful individual performance cannot make a collective performance. Therefore, the main requirements of group gymnastics are to obey the unified command and to have consistent movements. Everyone in the group is an individual with strong executive power. For the individual, the movement and the path of travel are not difficult, but the group gymnastics is based on the whole, and it is necessary to interpret the overall presentation effect and show it to the audience. All individuals are required to coordinate their movements to reach a designated location within a specific time [13].

Group gymnastics not only expresses an artistic effect but also expresses the central idea. The formation needs to be in accordance with the requirements of the exercise so that the performers can perform their movements on the stage with agility and regularity. The shocking effect of group gymnastics is achieved through the presentation of various patterns and formations. The practice of group gymnastics needs to cultivate group awareness and group cooperation. This is not just an artistic presentation, but a collective spirit. One of the basic elements of group gymnastics is formation. Exploring the transformation of the formation path is to allow the performers to practice more efficiently and present a more exciting performance. The visual effect of group gymnastics is inspiring, so the spread of civilized culture can be achieved through group gymnastics, which will have a good effect [14, 15].

*3.3. Application of Computer Technology in Group Gymnastics Formation.* The era of the Internet will rapidly enter human civilization with the birth of the computer, and the way of life of human beings has undergone tremendous changes. People are no longer purely handmade everyday objects, nor are they limited to cash transactions. Both the way of production and the way of consumption have undergone earth-shaking changes. In recent years, computer technology has been applied to natural and social sciences, and as a trend calling for sports culture, it is imperative to accept the baptism of the information age as group operation as a sports art [16].

The computer-aided group gymnastics technology started from scratch, and there are three most important application elements in its development process, namely, people, system, and technology. If the development process of computer-aided group gymnastics is regarded as a technical application, then in this application, people are the foundation, the system is the premise, and the technology is the guarantee. It is the human element that combines group gymnastics with computer technology, and technologies such as computer simulation algorithms appear. At the same time, it is also the person who uses the computer simulation algorithm in practice, sums up experience, and keeps innovating, so that the computer simulation technology can continue to develop [17].

In recent years, the development of high and new technology in the application field and the wide application of computer technology have opened up a wider space for the study of group gymnastics, for example, developing software for group exercise path design and arranging formations through coordinate points. The application of computer technology in the group gymnastics formation change path algorithm can strengthen the connection between people and paths. It is an efficient group gym formation change path algorithm simulation system [18, 19].

*3.4. Related Algorithms of the Shortest Path.* In the computer simulation algorithm, the most critical part is choosing the most appropriate path planning for group gymnastics, and the performance path of each performer is calculated by the shortest path algorithm. The algorithm is also widely used in various industries, such as logistics transportation, intelligent transportation, and emergency first aid. In the actual gymnastics formation transformation path, the $Dijkstra$ algorithm is often used to solve the shortest path between two points [20, 21].

The traditional $Dijkstra$ algorithm generates the shortest path according to the increasing order of the path length, and it is used to calculate the shortest path from an initial point to other nodes. In actual group gymnastics formation transformation path calculation, $Dijkstra$ algorithm is often used to solve the shortest path between two points. When the algorithm is executed, the nodes in the network are divided into three types: unmarked nodes, temporary marked nodes, and marked nodes. When initializing the algorithm, the nodes in the network are initialized as unmarked nodes, and the temporary nodes are defined as the nodes connected to the shortest path nodes during the search process. Every time the algorithm loops, it is necessary to find the shortest path corresponding to the temporary node set, which changes from a temporary node to a marked node. When all nodes are marked nodes, the algorithm ends.

Storage structure optimization *Dijkstra* algorithm adopts the storage structure of the adjacency list. The adjacency list establishes an array $a[v]$ $(v = 0, 1, 2, \ldots n)$ for each node in Figure 1 to store the information of the edge connected to the node; that is, each element in the array represents the edge starting from the node $v$. Using adjacency list storage can save a lot of storage space. Therefore, aiming at the problem of large data redundancy, this paper adopts the adjacency list data structure to store the formation transformation path of group gymnastics to reduce the space complexity of the algorithm [22].

The traditional *Dijkstra* algorithm is a common shortest path algorithm. However, in order to overcome the problems of many search nodes, wide range, and long-time consumption, this paper introduces the rectangle search algorithm and the ellipse search algorithm, and analyzes the two algorithms. The article combines the big data and artificial intelligence to give the search range and area formulas of the two algorithms, and finally conducts experimental comparison and analysis.

*3.4.1. Ellipse Search Algorithm.* The ellipse search algorithm is an algorithm based on the traditional *Dijkstra* algorithm. The difference is that because the algorithm searches based on ellipses. Compared with the traditional *Dijkstra* algorithm, the ellipse search algorithm has fewer search nodes. The traditional *Dijkstra* algorithm is to find the shortest path through a circular search range, as shown in Figure 2. The search area in the traditional *Dijkstra* algorithm is a circle. Although the search results of the circular search method are more accurate, the search area is too wide and the algorithm complexity is high, which affects the real-time performance of the experiment [23].

In order to solve the shortcomings of the traditional *Dijkstra* algorithm, the ellipse search algorithm sets a feature attribute for each node in the traditional *Dijkstra* algorithm, which is used as the basis for being selected as a marker node, which increases the directionality of the *Dijkstra* algorithm, as shown in Figure 3, reducing the number of search nodes to improve the efficiency of the algorithm.

The search range of the ellipse search algorithm is shown in Figure 4, and its boundary satisfies the ellipse trajectory of formula (1), and the shortest path can be found between the nodes inside the ellipse. The calculation process of its elliptical trajectory is shown in following formulas:

$$\left|ov_i\right| + \left|v_i d\right| = 2a, \tag{1}$$

where $o$ indicates the starting node, $d$ indicates the termination node, and $|ov_i|$ indicates the distance from the starting point $o$ to any node $v_i$.where $r_0$ represents a parameter of the set $T$ and $D_{od}$ represents the straight-line distance from node $o$ to node $d$.

$$2a = r_0|od|, \tag{2}$$

$$A = O \times D\{(o, d)|o \in O|d \in D\}, \tag{3}$$

$$r = \frac{P_{od}}{D_{od}} = \frac{P_{od}|_1 + P_{od}|_2 + \cdots P_{od}|_k}{kD|_1}, \tag{4}$$

$$r = \frac{1}{k}\left(\frac{1}{\cos\theta_1} + \frac{1}{\cos\theta_2} + \cdots + \frac{1}{\cos\theta_k}\right), \tag{5}$$

$$r = \frac{1}{k}\sum_{1}^{k}\frac{1}{\cos\theta_i}. \tag{6}$$

Among them, the calculation process of $r$ is shown in Figure 5. Where $k$ indicates the equal portion into which the $D_{od}$ is divided.

$$r_{\max} = \frac{1}{k}\sum_{1}^{k}\frac{1}{\cos\theta_i} = \sqrt{2}, \tag{7}$$

$$\mu = E\left(\frac{1}{\cos\theta}\right) \approx 1.122, \tag{8}$$

$$\sigma^2 = D\left(\frac{1}{\cos\theta}\right) \approx 0.01412. \tag{9}$$

*3.4.2. Rectangle Search Algorithm.* The ellipse search algorithm calculates the nodes in the ellipse. While reducing the number of search nodes, it takes too much time to determine whether the nodes are in the ellipse. The rectangle search algorithm reduces the amount of computation by calculating the enclosing rectangle of the ellipse and using the enclosing rectangle as the search area [24–26]. Its search range is shown in Figure 6.

As shown in Figure 6, the method is to find the circumscribed rectangle that is tangent to the ellipse, for example, $ABC\ D$ or $A_1B_1C_1D_1$ in Figure 6, which is usually divided into a circumscribed rectangle based on a standard ellipse and a circumscribed rectangle based on a general ellipse.

The circumscribed rectangle based on the standard ellipse is the search range area to find the rectangle with the center of the ellipse as the origin. As shown in Figure 7, its satisfying conditions are shown in following formulas:

$$x_o = x_d = c, \tag{10}$$

$$r|od| = 2a. \tag{11}$$

Changing the ellipse in the special case is to get the ellipse in the general case, as shown in Figure 8. Its calculation formula is shown in following formulas:where $\theta$ represents the rotation angle based on the standard ellipse, $x_c$ represents the distance that the standard ellipse is translated on

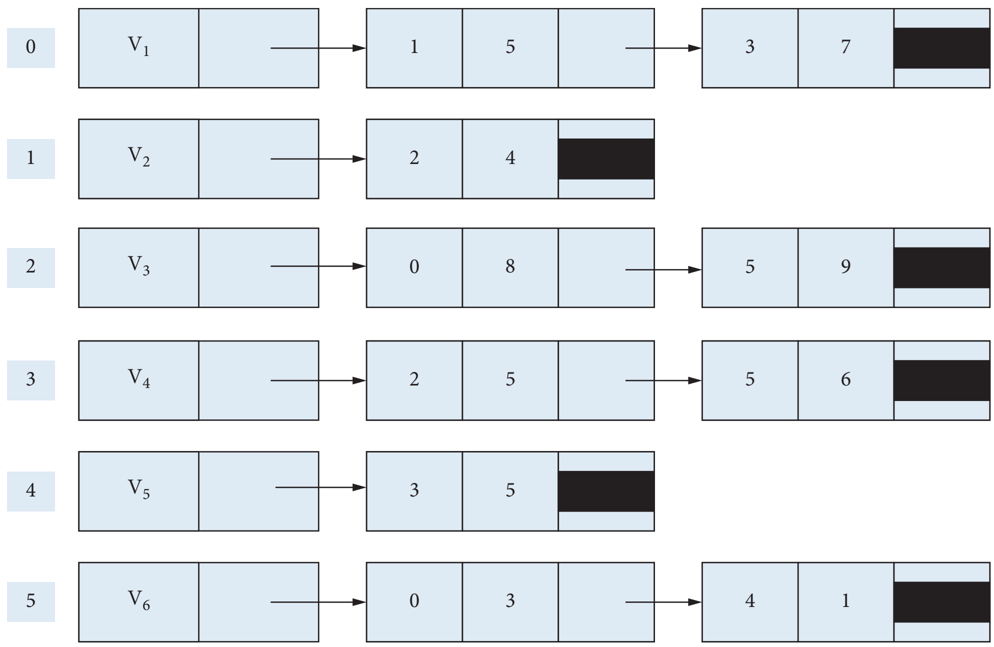


Figure 1: Adjacency list.

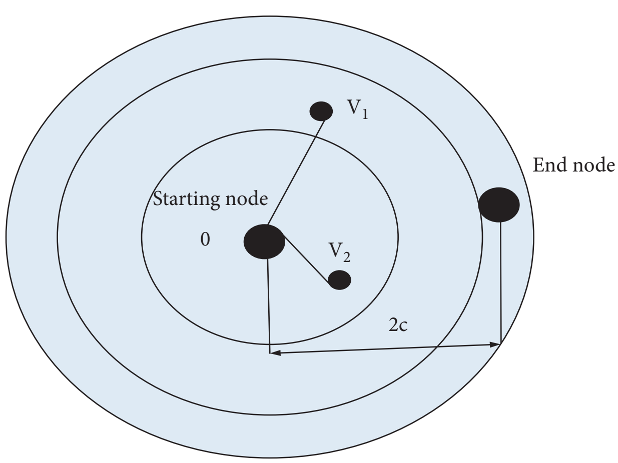


Figure 2: Traditional Dijkstra algorithm.

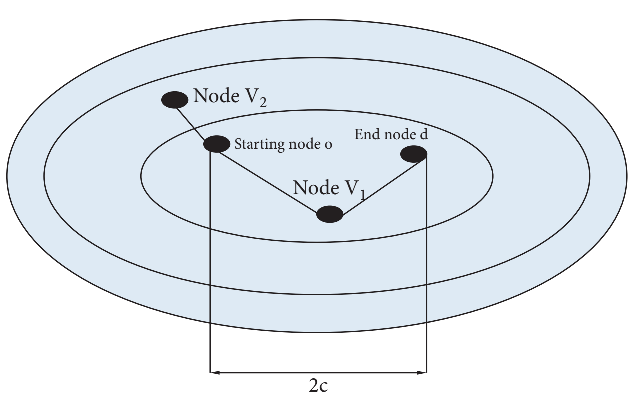


Figure 3: Dijkstra algorithm for ellipse restricted search area.

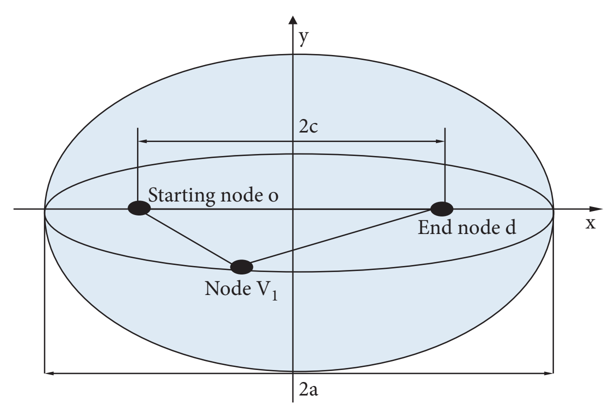


Figure 4: Schematic diagram of ellipse search range.

the axis, and $y_c$ indicates the distance that the standard ellipse is translated on the $y$ axis.

$$\frac{[(x-x_c)\cos\theta+(y-y_c)\sin\theta]^2}{a^2}+\frac{[-(x-x_c)\sin\theta+(y-y_c)\cos\theta]^2}{b^2}=1, \tag{12}$$

$$c^2+b^2=a^2, \tag{13}$$

$$x_c=\frac{x_o+x_d}{2}, \tag{14}$$

$$y_c=\frac{y_o+y_d}{2}, \tag{15}$$

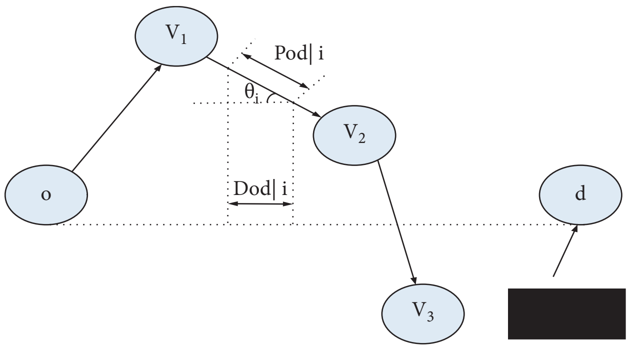


Figure 5: Schematic diagram of $r$ value.

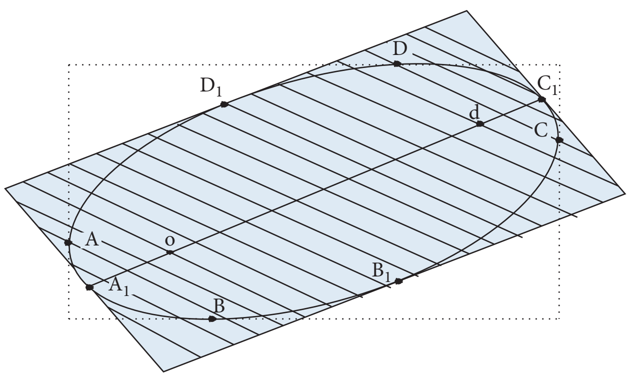


Figure 6: Schematic diagram of rectangular search range.

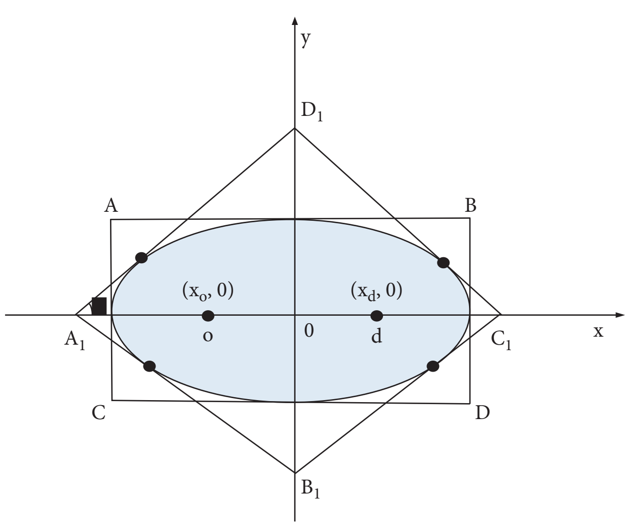


Figure 7: The maximum value map of rectangular search area.

$$\theta = \arctan\frac{y_o - y_d}{x_o - x_d}, \tag{16}$$

$$x_m = x_c \pm \sqrt{a^2\cos^2\theta + b^2\sin^2\theta}, \tag{17}$$

$$y_m = y_c \pm \sqrt{b^2\cos^2\theta + a^2\sin^2\theta}, \tag{18}$$

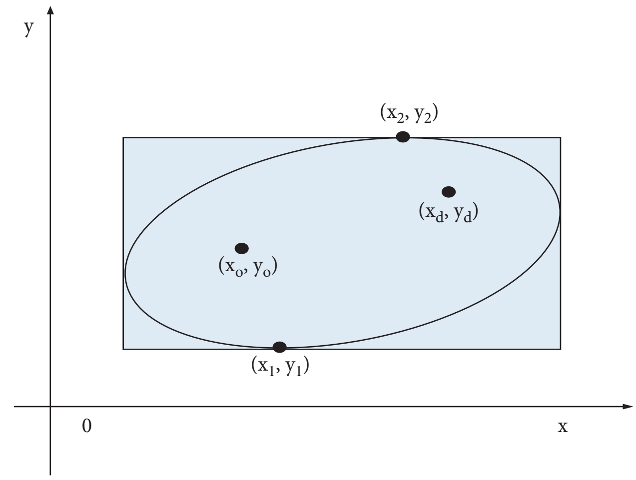


Figure 8: Schematic diagram of rectangular search range based on general ellipse.

Then, the simplified formula for $x_m, y_m$ is obtained as follows:

$$x_m = x_c \pm |od|\sqrt{r^2 - \sin^2\theta}, \tag{19}$$

$$y_m = y_c \pm |od|\sqrt{r^2 - \cos^2\theta}, \tag{20}$$

where $x_m$ is the maximum and minimum values of the abscissa of the rectangle border, $y_m$ is the maximum and minimum values of the vertical coordinates of the rectangle border, and $|od|$ indicates the distance between the start node $o$ and the end node $d$.

## 4. Algorithm Experiment Comparative Analysis

*4.1. Experimental Comparative Analysis of Improved Ellipse Algorithm and Traditional Dijkstra Algorithm.* This paper conducts a comparative experiment between the improved ellipse algorithm and the traditional *Dijkstra* algorithm through environmental testing [27, 28]. The first is the time used to search the area. The traditional *Dijkstra* algorithm search area formula is shown in formula (21). The formula for the search area of the improved ellipse algorithm is shown in formula (22). The second is the time spent searching for a path. The experimental data are selected from the real data of the team gym formation path of $A$.

$$S_{Dijistra} = \pi r^2 = \pi\left(\frac{r+1}{2}|od|^2\right), \tag{21}$$

$$S_{ellipse} = \pi ab = \pi\frac{r|od|}{2}\,\frac{\sqrt{\left(r^2 - 1\right)}|od|}{2}. \tag{22}$$

*4.1.1. Area Comparison.* When the ratio of the search area between the improved ellipse algorithm and the traditional *Dijkstra* algorithm reaches the maximum value, the situation that the shortest path cannot be found due to the small search range can be avoided. As shown in Table 1, when $r$ is

TABLE 1: The ratio of the search area of the two algorithms.

| The value of the coefficient $r$ | The area ratio of the improved ellipse algorithm and the traditional algorithm |
|---|---|
| 1.15 | 0.142 |
| 1.20 | 0.168 |
| 1.25 | 0.185 |
| 1.30 | 0.205 |
| 1.35 | 0.222 |
| 1.40 | 0.239 |

the maximum value, the ratio of the search area of the two algorithms is the largest, which not only improves the reliability of the algorithm, but also improves the efficiency of the algorithm.

As can be seen from Figure 9, compared with the traditional *Dijkstra* algorithm, the improved ellipse algorithm has a significantly smaller search area than the traditional *Dijkstra* algorithm. When the distance between the two nodes of the shortest path is 6, the search area of the improved ellipse algorithm is 42 km ∗ km, while the traditional *Dijkstra* algorithm reaches 165 km ∗ km. When the search area is smaller, the number of search nodes is smaller, which shows that the improved ellipse algorithm can reduce the number of search nodes and reduce the complexity of the algorithm.

*4.1.2. Search Path Time Comparison.* It is not difficult to see from Figure 10 that compared with the traditional *Dijkstra* algorithm, the ellipse improved algorithm takes less time to search for a path. When the distance between the two nodes of the shortest path is 6 km, the improved ellipse algorithm takes 3.5 s, and the traditional *Dijkstra* algorithm takes 6.5 s. This shows that the execution efficiency of the improved ellipse algorithm is high.

*4.2. Experimental Comparative Analysis of Rectangle Search Algorithm and Traditional Dijkstra Algorithm.* The experimental data are selected from the real data of the team gym formation path of A. There are two indicators for evaluating the algorithm: the first is the number of nodes searched, and the second is the time spent searching the path.

*4.2.1. Comparison of the Number of Nodes.* As shown in Figure 11, when traversing, the number of nodes in the rectangle search algorithm is much less than that of the traditional *Dijkstra* algorithm. When the straight line distance of the shortest path point pair to be found is the same, the rectangle search algorithm has a maximum of 451 nodes, while the traditional *Dijkstra* algorithm reaches 763 nodes. This shows that the efficiency of the rectangle search algorithm is better.

*4.2.2. Comparison of Time Consumed When Searching for a Path.* As shown in Figure 12, as the straight-line distance between two nodes increases, the time consumed by the rectangle search algorithm to find the shortest path is much less than that of the *Dijkstra* algorithm.

*4.3. Comparative Analysis of Ellipse Search Algorithm and Rectangle Search Algorithm.* This paper compares the ellipse search algorithm with the rectangle search algorithm to find the optimal algorithm. The article will be evaluated from two aspects: the first is the search area and the second is the time consumed by the path search. Its area formula is shown in following formulas:

$$S_R = 4ab = 4r\sqrt{r^2 - 1}|od|^2, \tag{23}$$

$$S_R = 2\left(a^2 + b^2\right) = 2\left(2r^2 - 1\right)|od|^2. \tag{24}$$

*4.3.1. Comparison of Search Area.* When the ratio of the search areas of the two algorithms reaches the minimum value, the number of nodes can be reduced while ensuring that the maximum area is within a reasonable range, as shown in following formulas:

$$\frac{S_{R\max}}{S_{ellipse}} = \frac{2\left(a^2 + b^2\right)}{\pi ab} = \frac{4r^2 - 2}{\pi r\sqrt{r^2 - 1}}, \tag{25}$$

$$\frac{S_{R\min}}{S_{ellipse}} = \frac{4ab}{\pi ab} \approx 1.27. \tag{26}$$

As shown in Table 2, when $r = \sqrt{2}$, the ratio of the search area of the ellipse search algorithm to the rectangle search algorithm is the smallest and compared with the search area of the *Dijkstra* algorithm, the search area of the rectangle search algorithm is slightly larger than that of the ellipse search algorithm, but not much. But the rectangle search algorithm is more likely to find the shortest path than the ellipse search algorithm.

*4.3.2. Comparison of Search Time.* It is not difficult to see from Table 3 that when the distance between the two nodes of the shortest path to be found increases, the time used by the rectangle search algorithm is much lower than that of the ellipse search algorithm, and when the straight-line distance between two nodes is 1.5, the ellipse search algorithm takes 1.45 s, whereas the rectangle search algorithm takes only 0.3 s, which shows that the algorithm greatly saves the time used.

## 5. Discussion

Science and technology are primary productive forces. The comprehensive development of the Internet and the continuous breakthroughs in the computer field have contributed to the arrival of the era of big data and artificial intelligence. Big data can more and more accurately target the needs of target customers, and artificial intelligence will also replace traditional repetitive work, greatly improving the efficiency of people's processing of things in life [29–31].

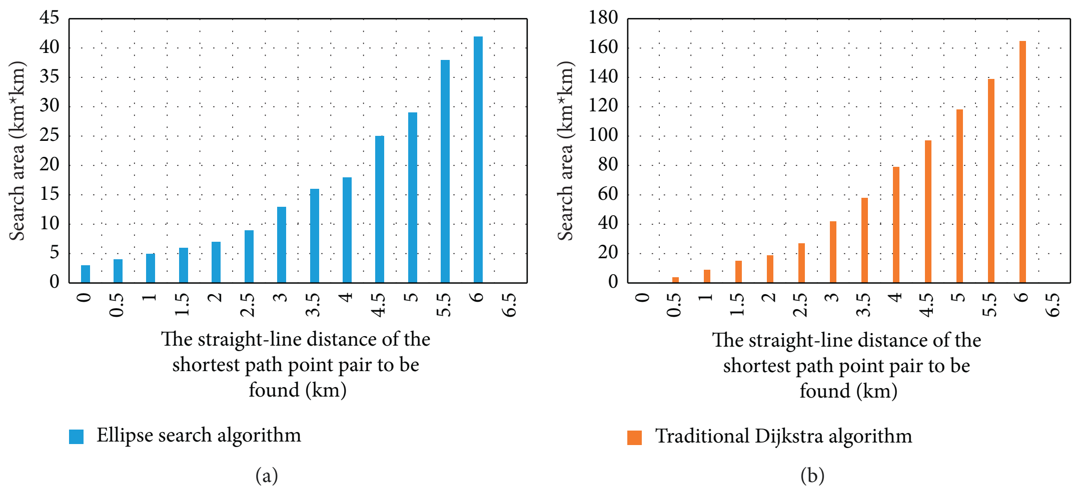


FIGURE 9: Comparison of the search area of the two algorithms. (a) Graph of search area data of improved ellipse algorithm. (b) Traditional *Dijkstra* algorithm search area data plot.

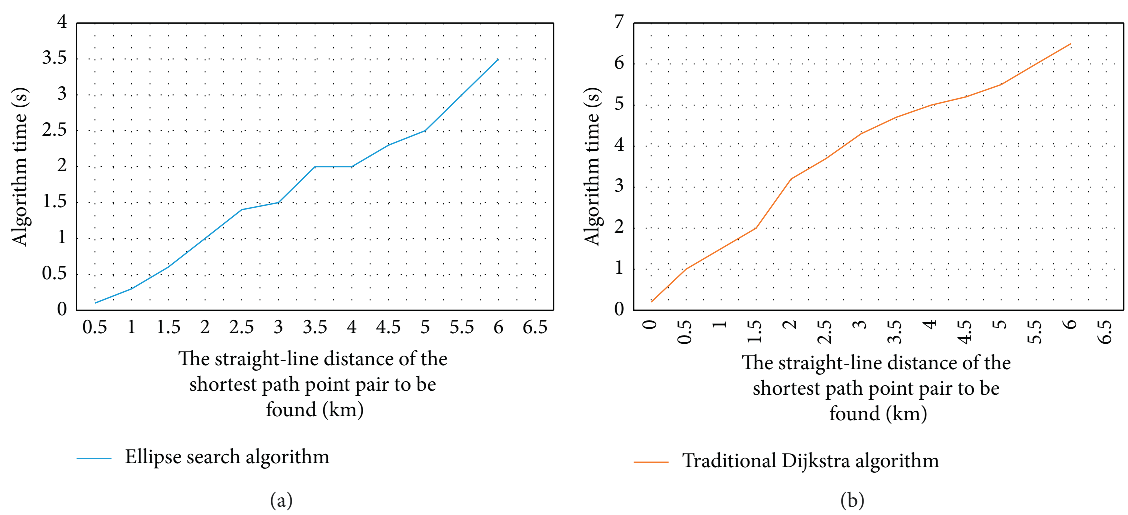


FIGURE 10: Comparison of the time used by the two algorithms. (a) Time data graph of the improved ellipse algorithm. (b) Time data plot of the traditional *Dijkstra* algorithm.

Through the comparison of ellipse search algorithm, rectangle search algorithm and traditional *Dijkstra* algorithm, and the comparison experiment between ellipse search algorithm and rectangle search algorithm, this paper explores the computer simulation algorithm of team gym formation path under artificial intelligence and big data [32]. And the following conclusions can be drawn:

(1) Through the comparative analysis between the ellipse search algorithm and the traditional *Dijkstra* algorithm, when the distance between the two nodes of the shortest path to be found increases, the search area of the ellipse search algorithm is significantly smaller than that of the *Dijkstra* algorithm. This shows that the ellipse search algorithm has excellent performance.

(2) Search path time comparison. When the distance between the two nodes of the shortest path to be found is relatively close, the time used by the two algorithms to search for the path is approximately the same as the time taken by the *Dijkstra* algorithm.

(3) The comparison between the rectangle search algorithm and the traditional *Dijkstra* algorithm experiment. The number of nodes traversed by the two algorithms in the path-finding process increases as the distance between the two nodes of the shortest path to be found increases. This is because the number of nodes traversed by the algorithm is proportional to the area traversed by the algorithm.

(4) When the distance between the two nodes of the shortest path to be found increases, the time used by the two search algorithms increases. However, the time efficiency of the rectangle search algorithm is still higher than that of the *Dijkstra* algorithm.

(5) The comparative analysis of the ellipse search algorithm and the rectangle search algorithm shows

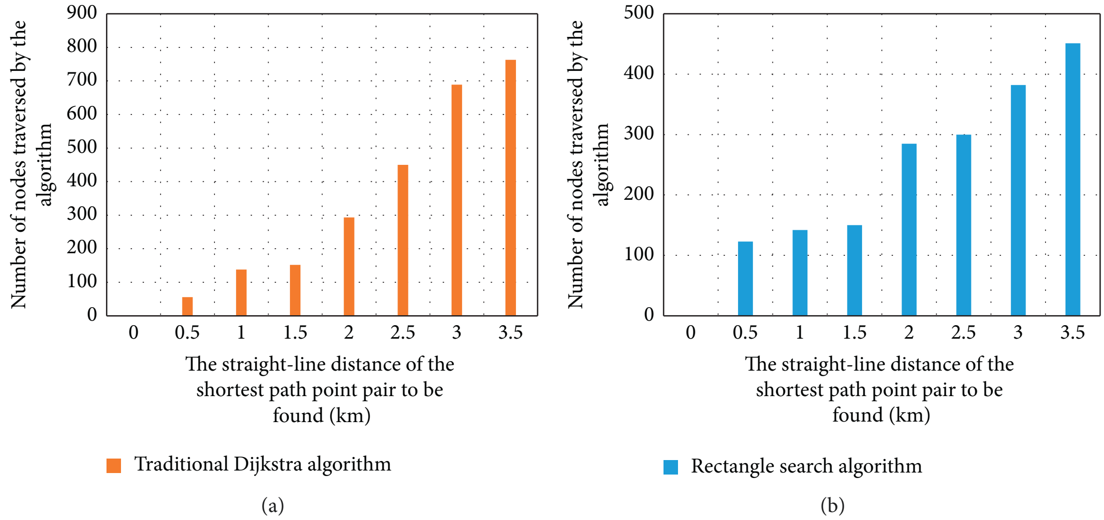


FIGURE 11: Comparison of the time used by the two algorithms. (a) The number of nodes traversed data graph of the rectangle search algorithm. (b) Traditional *Dijkstra* algorithm node count traversal data graph.

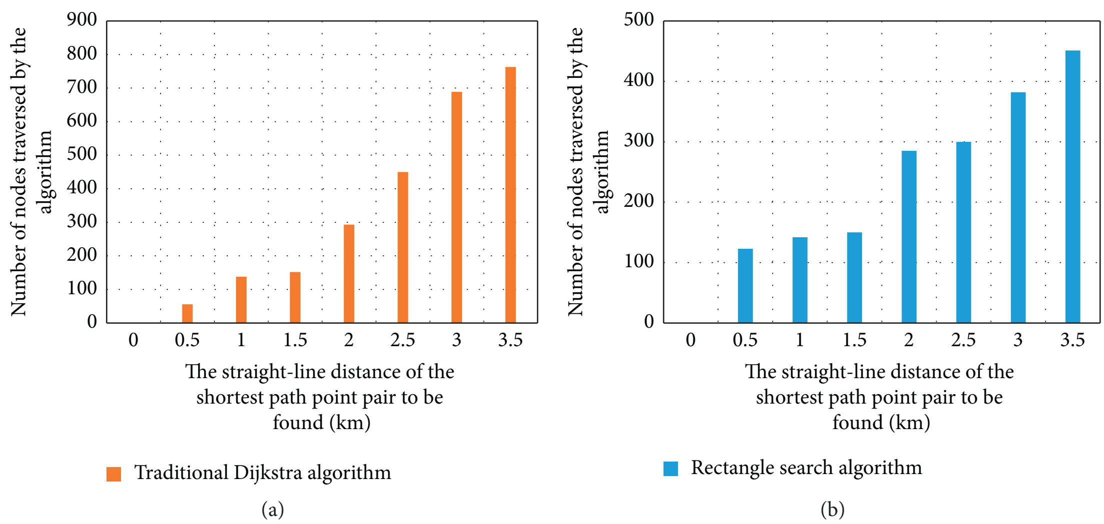


FIGURE 12: Time comparison of the two algorithms. (a) Graph of the time consumed by the rectangle search algorithm to search for a path. (b) A graph of the time spent in traditional *Dijkstra* searching for a path.

TABLE 2: The ratio of the search area of the two algorithms.

| The value of the coefficient $r$ | Rectangle algorithm and ellipse algorithm search area ratio |
|---|---|
| 1.15 | 1.60 |
| 1.20 | 1.51 |
| 1.25 | 1.43 |
| 1.30 | 1.41 |
| 1.35 | 1.375 |
| 1.40 | 1.36 |

that the rectangle search algorithm has a higher probability of finding the shortest path, which shows that the reliability of the algorithm is better.

(6) The ellipse search algorithm needs to perform complex operations in the search process to determine whether a node falls within the ellipse, which takes a long time. The rectangle search algorithm only needs to compare the size of the coordinate values, which saves the time of the algorithm.

The whole comparative test data show that the rectangular search algorithm improves the reliability of the algorithm and saves time compared with the ellipse search

Table 3: Time comparison of the two algorithms.

| The straight-line distance of the shortest path point pair to be found (km) | Algorithm search time (s) | |
|---|---|---|
| | Ellipse search algorithm | Rectangle search algorithm |
| 0.5 | 0.2 | 0 |
| 1.0 | 0.35 | 0.1 |
| 1.5 | 1.45 | 0.3 |
| 2.0 | 1.73 | 1.3 |
| 2.5 | 1.98 | 1.45 |
| 3.0 | 2.1 | 1.76 |
| 3.5 | 3.2 | 1.89 |
| 4.0 | 3.98 | 2.1 |

algorithm in terms of algorithm search area and search time. Therefore, the rectangle search algorithm has the best effect of optimizing the $Dijkstra$ algorithm.

## 6. Conclusion

In the era of the Internet, science and technology have undoubtedly promoted the advancement of various fields, including artificial intelligence, big data, and the Internet of Things. The computer simulation algorithm of group gymnastics formation transformation path has also obtained a new development direction under the Internet technologies such as big data and artificial intelligence. This paper chooses the adjacency list storage method to optimize the $Dijkstra$ algorithm when finding the shortest path in the gymnastics formation. Then, in view of the problems that the traditional $Dijkstra$ algorithm has many search nodes, large range, and high time and space complexity in the process of finding the shortest path, through the experimental comparison of the rectangular search algorithm and the ellipse search algorithm, the rectangular search algorithm and the ellipse search algorithm are compared. The performance of the search algorithm is superior. Through the analysis of computer simulation results, in the actual group exercise process, the rectangular search algorithm can more efficiently find the travel route of each performer, thereby improving the efficiency of group exercises. In this paper, the area formulas of rectangle and ellipse search algorithms are also obtained according to the characteristics of group gymnastics formation transformation. This paper explores the computer simulation algorithm of group gymnastics formation change path and has achieved some results. Thereby, it promotes the progress of the related work of group gymnastics formation and has a very good application value. Team gymnastics formations are very complex and involve a wide range of areas. Due to the author's limited time and energy, and the limitation of resources, this article has some shortcomings, such as optimizing other algorithms of the traditional $Dijkstra$ algorithm. It does not take into account other interference factors that affect group gymnastics formation and the exercise effect of rectangle search algorithm on group gymnastics formation.

## Data Availability

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

## Conflicts of Interest

The authors state that they have no conflicts of interest.

## References


[1] M. K. Tripathi, A. Nath, T. P. Singh, and A. S. P. Ethayathulla, "Evolving scenario of big data and Artificial Intelligence (AI) in drug discovery," *Molecular Diversity*, vol. 25, no. 3, pp. 1439–1460, 2021.

[2] R. R. v. d Leur, M. J. Boonstra, A. Bagheri, and R. W. A. K. P. A. P. v. d.P. M. v.R. J. R. v.F. W. Roudijk, "Big data and artificial intelligence: opportunities and threats in electrophysiology," *Arrhythmia & Electrophysiology Review*, vol. 9, no. 3, pp. 146–154, 2020.

[3] A. Nayarisseri, R. Khandelwal, P. Tanwar et al., "Artificial intelligence, big data and machine learning approaches in precision medicine & drug discovery," *Current Drug Targets*, vol. 22, no. 6, pp. 631–655, 2021.

[4] Y. S. Jeong and J. H. Park, "Advanced big data analysis, artificial intelligence & communication systems," *Journal of Information Processing Systems*, vol. 15, no. 1, pp. 1–6, 2019.

[5] R. Foresti, S. Rossi, M. Magnani, and C. N. Guarino Lo Bianco, "Smart society and artificial intelligence: big data scheduling and the global standard method applied to smart maintenance," *Engineering*, vol. 6, no. 7, pp. 835–846, 2020.

[6] C. Iwendi, S. U. Rehman, A. R. Javed, and S. G. Khan, "Sustainable security for the internet of things using artificial intelligence architectures," *ACM Transactions on Internet Technology*, vol. 21, no. 3, pp. 1–22, 2021.

[7] Youngmin, Ji, and Junjae, "Internet of things, big-data and artificial intelligence," *Communications of the Korean Institute of Information Scientists and Engineers*, vol. 35, no. 7, pp. 43–50, 2017.

[8] I. Giuffrida, F. I. Lederer, and N. Vermeys, "A legal perspective on the trials and tribulations of AI: how artificial intelligence, the internet of things, smart contracts, and other technologies will affect the law," *Case Western Reserve Law Review*, vol. 68, no. 3, p. 14, 2018.

[9] B. Parker and C. Bach, "The synthesis of blockchain, artificial intelligence and internet of things," *European Journal of Engineering Research and Science*, vol. 5, no. 5, pp. 588–593, 2020.

[10] G. K. Durbhak and B. Selvaraj, "Convergence of artificial intelligence and internet of things in predictive maintenance systems – a review," *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, vol. 12, no. 11, pp. 205–214, 2021.

[11] J. M. Tien, "Internet of things, real-time decision making, and artificial intelligence," *Annals of Data Science*, vol. 4, no. 2, pp. 149–178, 2017.

[12] N. An and X. Wang, "Legal protection of artificial intelligence data and algorithms from the perspective of internet of things resource sharing," *Wireless Communications and Mobile Computing*, vol. 2021, no. 2, pp. 1–10, 2021.

[13] B. H. d. Silva, B. A. Vieira, and R. S. Delevatti, "The addition of strength training to practice of high intensity group gymnastics may not imply in highest levels of strength and quality

of life: a cross-sectional study," *Health*, vol. 11, no. 07, pp. 896–904, 2019.

[14] M. Behnam and F. Taghizadeh, "The influence of motivation on group cohesion in aerobic gymnastics athletes," *Sport Science*, vol. 11, no. 1, pp. 102–105, 2018.

[15] V. K. Karania, "Evaluation of age & dementia friendly gymnastics programme," *Working with Older People*, vol. 21, no. 3, pp. 140–146, 2017.

[16] F. D. Wright and T. M. Conte, "Standards: roadmapping computer technology trends enlightens industry," *Computer*, vol. 51, no. 6, pp. 100–103, 2018.

[17] J. C. L. Chow, "Internet-based computer technology on radiotherapy," *Reports of Practical Oncology and Radiotherapy*, vol. 22, no. 6, pp. 455–462, 2017.

[18] G. R. Tashmukhamedova, "Feature of the use of computer technology in the process of teaching A foreign language," *Acta of Turin Polytechnic University in Tashkent*, vol. 8, no. 1, p. 19, 2018.

[19] A. Kumar, "A study on attitude and opinion towards using computer technology in teaching among B.ed. Trainees in tiruchirappalli district," *i-manager's Journal of Educational Technology*, vol. 12, no. 1, pp. 36–51, 2015.

[20] Y. Marinakis, A. Migdalas, and A. Sifaleras, "A hybrid particle swarm optimization - variable neighborhood search algorithm for constrained shortest path problems," *European Journal of Operational Research*, vol. 261, no. 3, pp. 819–834, 2017.

[21] S. Zhang and Y. Zhang, "A hybrid genetic and ant colony algorithm for finding the shortest path in dynamic traffic networks," *Automatic Control and Computer Sciences*, vol. 52, no. 1, pp. 67–76, 2018.

[22] Y. Wang, X. Li, and R. Ruiz, "An exact algorithm for the shortest path problem with position-based learning effects," *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, vol. 47, no. 11, pp. 3037–3049, 2017.

[23] F. Y. Nurhasanah, W. Gata, D. Riana, and M. S. F. Jamil, "Shortest path finding using dijkstra's algorithm," *PIKSEL : Penelitian Ilmu Komputer Sistem Embedded and Logic*, vol. 9, no. 1, pp. 89–102, 2021.

[24] A. Khani, "An online shortest path algorithm for reliable routing in schedule-based transit networks considering transfer failure probability," *Transportation Research Part B: Methodological*, vol. 126, no. AUG, pp. 549–564, 2019.

[25] P. Rathore and V. Kumar, "Optimization and energy efficient analysis of shortest path algorithm in WSN for node failure," *International Journal of Computer Application*, vol. 167, no. 10, pp. 36–42, 2017.

[26] H. Song, G. A. Fink, and S. Jeschke, *Security and Privacy in Cyber-Physical Systems: Foundations, Principles and Applications*, pp. 1–472, Wiley-IEEE Press, Chichester, UK, 2017.

[27] A. Ramesh Khaparde, F. Alassery, A. Kumar, Y. Alotaibi, and O. Ibrahim Khalaf, "Differential evolution algorithm with hierarchical fair competition model," *Intelligent Automation & Soft Computing*, vol. 33, no. 2, pp. 1045–1062, 2022.

[28] M. Javed Awan, M. Shafry Mohd Rahim, H. Nobanee, A. Yasin, O. Ibrahim Khalaf, and U. Ishfaq, "A big data approach to black Friday sales," *Intelligent Automation & Soft Computing*, vol. 27, no. 3, pp. 785–797, 2021.

[29] A. Xl, L. A. Hao, W. Weixi, Z. Ye, L. Haibin, and L. Zhihan, "Big data analysis of the internet of things in the digital twins of smart city based on deep learning," vol. 128, pp. 167–177, 2021.

[30] Z. Lv, R. Lou, J. Li, and A. K. H. Singh, "Big data analytics for 6G-enabled massive internet of things," *IEEE Internet of Things Journal*, vol. 8, no. 7, pp. 5350–5359, 2021.

[31] C. A. Tavera Romero, J. H. Ortiz, O. I. Khalaf, and A. Ríos Prado, "Business intelligence: business evolution after industry 4.0," *Sustainability*, vol. 13, no. 18, p. 10026, 2021.

[32] M. AtiquzzamanNeilYenZhengXu, "Big data analytics for cyber-physical system in smart city," *BDCPS*, pp. 28-29, 2019.