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ORIGINAL

TACTICAL OPTIMISATION AND OPPONENT ANALYSIS FOR FOOTBALL TEAMS WITH BIG DATA MINING AND MACHINE LEARNING

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ABSTRACT

Football tactical training is of great significance to the improvement of football level and the development of football, while the tactical training system is rich in content and diversified in structure, how to coordinate the content of tactical training system has become a key topic to improve the effectiveness of tactical training. In this paper, we design the method of tactical training for college football teams, aiming at building a tactical optimisation and opponent analysis model based on big data mining and machine learning from the reality of tactical training for college high-level football teams. Specifically, the convolutional neural network with two levels of cascade detection and regression in the model adopts the classic ideas of face key point detection and human body key point detection: the idea of cascade regression is used for the detection of the key point location from coarse to fine; the heat map of the key point obtained from the first level network is used as the supplemental information, and the original map is used for the feature fusion; the Heatmap, which has better effect, is used as the Ground Truth of the network; the Heatmap is used as the ground truth of the network; the Heatmap, which has better effect, is used as the ground truth of the network. The second stage regression network uses Heatmap as the Ground Truth of the network, which provides pixel-by-pixel supervision for the regression of the key points' positions and the prediction of whether the key points are visible or not. In addition, this paper combines the idea of adversarial learning to design the loss function to solve the fuzzy problem of regression-to-

the-mean when regressing Heatmap. The second-stage network is used as the generator, and the discriminator is designed to define the loss function to judge the reliability of the generated Heatmap. Through the training method of adversarial learning, the second-stage network converges and predicts the reliable Heatmap, and then obtains the key point coordinates to identify the opponents to optimise the tactics of football teams. The final simulation experimental results demonstrate the effectiveness and superiority of the proposed model.

KEYWORDS: Tactical Optimisation; Opponent Analysis for Football Teams; Big Data Mining; Machine Learning; Deep Learning

1. INTRODUCTION

As a highly popular and widely participated sport in the world, football has attracted extensive attention from all sectors of the community. As far as the development of football is concerned, the sport is developing in a stable and favourable manner. In terms of the development of university football matches, some of the matches have been held for more than 100,000 times, the development of football in society has also formed a certain scale, and in 2017, more than 20,000 amateur football matches were held; the development of professional football has even presented a sizable situation, with professional leagues being carried out in full swing. The development of football has a good foundation, but the development of football, in addition to the supply of macro-environment, also needs to be solid micro-level skills and tactics and other basic qualities. Therefore, how to improve the technical and tactical level has become an urgent problem for high-level football teams (Gonzalez-Rodenas, Lopez-Bondia, Calabuig, James, & Aranda, 2015; González-Víllora, Serra-Olivares, Pastor-Vicedo, & Da Costa, 2015).

High-level football players are the backbone of the revitalisation of the sport, and the importance of their tactical training is self-evident. In the tactical training of high-level football players, there is basically a continuation of the uniform training programme, that is, high-level football players in the same team are trained in a uniform way, in which the physical training is relatively single, the technical and tactical training is only temporarily instructed by the coach on the field of play, and the proportion of the tactical awareness training is even more negligible. Under this mode of training, it is difficult for high-level football players to achieve significant improvement in their tactical ability, nor can they effectively improve the level of football tactics (Agyingi, Ngwa, & Wiandt, 2016).

There is an urgent need to improve the current mode of tactical training for the revitalisation of football and the development of high-level football players. The competitive state of football players in the course of a match is to a large extent determined by the level of athletic ability of the athletes. Tactical

ability is an important component of a football player's competitive ability. Tactical awareness is the core element in the formation of tactical ability (de Andrade, González-Víllora, Casanova, & Teoldo, 2020; Petiot, Silva, & Ometto, 2020). As a team sport, tactical awareness is particularly important. The level of tactical awareness shown by players in a match determines the effectiveness of the application of techniques and the play of tactical ability, and plays an important role in the outcome of the match. Football training is the most basic form of organisation of the sport and the most fundamental component of a training programme. The formation and improvement of competitive ability in football need to be accumulated through long-term training. The improvement of the level of tactical training of high-level football teams in colleges and universities is the cornerstone for the development of the overall level of high-level football teams in colleges and universities.

How to cultivate and improve the tactical awareness of football teams at a high level has always been an important topic in football tactical training (BARBU & STOICA, 2018; Carlos, Alfonso, Olga, Javier, & María, 2018). In football matches, the use of tactics mainly depends on the understanding, analysis and judgement of the opponents before the match, and then make careful tactical arrangements, and at the same time, it requires the on-field command and tactical co-ordination of the players on the field during the match. Football matches are ever-changing, no matter how detailed the pre-match deployment is and how timely and correct the on-field command is, it is impossible to accurately anticipate and deploy every action and decision on the field before the match. Therefore, it is extremely important to rely on the cultivation of a strong tactical awareness of the players on the field (AKYOL, CEYHAN, & CAPAPÉ, 2020; Bell & Hopper, 2003).

At the present stage, in the daily training of university high-level football teams, the main time of the team is spent on tactical training, which is the core content of a team. In modern football, attacking and defending require players to run actively, occupy favourable positions, act in unison, and give full play to the maximum energy of the whole team. The actual characteristics of the high level football teams in ordinary universities in China, which place equal emphasis on cultural studies and specialised training, dictate that training time is very limited and the systematic nature of training is very different from that of professional teams. Therefore, within the limited training time, seizing the essence of the game and the needs of football competition, scientifically and reasonably designing and arranging training sessions is particularly important for the improvement of the quality and effectiveness of the training of high-level football teams in ordinary universities.

Furthermore, on the basis of studying the characteristics and basic laws of the basic design of the tactical training of high-level college football teams, and analysing the relationship between the characteristics and laws of the

tactical training of high-level college football teams and the design of the training, the researchers try to explore and construct a methodological system of the theory and practice of the design of the tactical training of high-level college football teams, so as to provide theoretical references for the design of the tactical training of high-level college football teams.

This paper hopes that through the observation and empirical research on the tactical training of high-level football teams in different colleges and universities, we can understand the basic situation of the tactical training of high-level football teams in colleges and universities, understand the problems of the tactical training of high-level football teams, and analyse these problems in a targeted manner in the hope of exploring the strategies to improve the tactical training of high-level football teams, and hope that these strategies can be applied to the tactical training of high-level football teams, so as to improve the tactical training of high-level football teams. It is hoped that these strategic suggestions can be applied to the tactical training of high-level football teams, so as to promote the level of tactical training of university football teams, improve the quality of the development of university football teams and enhance the development of football (Vaughan, Mallett, Potrac, López-Felip, & Davids, 2021). The main contributions are as follows:

(1) In this paper, the proposed convolutional neural network with two-stage cascade of detection and regression adopts the classical ideas in face key point detection and human body key point detection, using the idea of cascade regression from coarse to fine for the detection of the key point location, and using the heat map of key points obtained from the first-stage network as the complementary information, and the feature fusion with the original map.

(2) This paper combines the idea of adversarial learning to design the loss function to solve the fuzzy problem of regression-to-the-mean when regressing Heatmap, takes the second-stage network as the generator, designs the discriminator, and defines the loss function to judge the reliability of the generated Heatmap. Through the training method of adversarial learning, the second-stage network converges and predicts the reliable Heatmap, and then obtains the key point coordinates to identify the opponent to optimise the tactics of football teams.

2. Methodology

In this paper, we propose a self-supervised pre-trained model designed for agent tasks targeting medical images to pave the way for the proposal of Transformer-based self-supervised medical image segmentation, and specify the details of each agent task. Then each important module of the model and the whole is described in detail, including the attention mechanism and the extraction of multi-scale semantic information.

2.1 Basic theory of tactical training design for football teams

Football tactics (Ötting & Karlis, 2023) are mainly ways and means to achieve victory in a football match. Football tactics include a wide range of elements, and the extent to which each factor affects the outcome of a match varies. Specifically, football tactics include the formations, techniques and playing styles of football teams. Formation is the external manifestation of the football team's response to the form of the match, and it is also an important part of football tactics. Generally speaking, formations enable us to understand indirectly the analysis and response of the coaches to the football matches. In the field of play, the formation can be seen through the positional structure formed by the organic arrangement of athletes, and once the formation is determined in a football match, it has a strong stability and seldom changes, and of course, when the situation on the field changes, the formation will also change adaptively. Technique is a key part of football tactics, and football technique is the basic way for high-level athletes to play football matches, and it is also the core of their match behaviour. Any meticulous tactical planning and tactical objectives ultimately require the skilled football skills of high-level players to ensure their realisation. Tactics rely on the effective use of skills to achieve their goals of attack and defence, and the flexible use of skills by football players is an important guarantee for the promotion of tactics.

Football tactics are mainly based on the three basic factors of formation, technique and style of play, but in fact, according to the complete tactical system, tactics also include such soft constraints as tactical guiding ideology and tactical awareness. Tactical guiding ideology is the basic guideline of football tactics, that is, the formulation of football tactics, the specific logic and the specific mode, etc. are all influenced by the tactical guiding ideology. Tactical guiding ideology provides the basic direction of football tactics and is the deep logic that guides the direction of tactics. Tactical guiding ideology is generally based on the analysis of the basic situation of the high level football team of the university and shows a kind of judgement on the development of the football game, and it is a guiding ideology because it can help to formulate correct and scientific strategic countermeasures. In any football team, there exists a fundamental tactical guiding ideology, which can effectively guide coaches to formulate tactical plans, and can effectively regulate the on-field behaviors and tactical styles of high-level athletes. Tactical awareness refers to a reaction to the tactical activities of high-level players during football matches. It is expressed in the player's awareness and behavior on the field of play. High-level players encounter various situations on the field, and match these situations with the tactical planning and deal with them in a timely manner, consciously analyses the opponent, time, distance and speed on the field, and reasonably make behaviors that help the football team. Tactical awareness of high-level football players is mainly about the players' grasp of various messages on the field of play, and their movement in the reality of the game, the flexible use of their own

skills and body movements to express, form an external form, and effectively convey the message to other team members.

Football tactics is a multi-layered system of contents, encompassing factors such as tactical ideology, tactical awareness, formations, styles of play, techniques and physical fitness, etc. Among them, tactical ideology is the fundamental factor in football tactics, and it can also exert an influence on other factors. Among them, the tactical ideology is the fundamental factor in football tactics, and at the same time, it can play a role in influencing other factors. Tactical awareness is mainly manifested on the field of play, and it is a kind of echo of the tactical guidance. Positions are the external manifestation of football tactics and are a form of football tactics. Play is a means of realizing the tactical objectives of football and plays a tool value in football tactics.

Technique is the specific content and foundation of football tactics and plays an important role in football tactics. Tactical guiding ideology, tactical awareness, formations, play, technology and physical fitness are united in the tactical system, specifically including tactical fitness, tactical awareness and football skills and tactics in three aspects, these three aspects in the internal system of the interlinked interplay, the formulation and implementation of tactics has an important significance, the content of the tactical training system of football as shown in Figure 1.

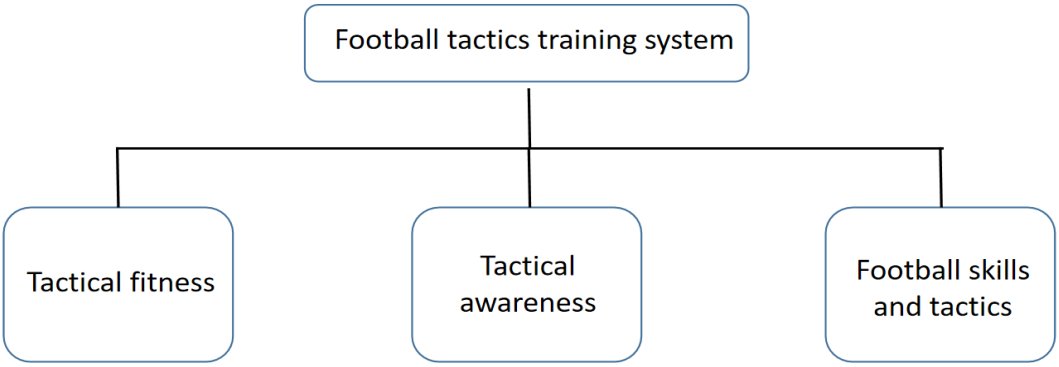

Figure 1: Schematic diagram of the contents of the football tactical training system.

2.1.1 Basic model of football team tactical training

Functional training mode refers to the designation of specific zones in the training ground according to the positions of high level football players in order to train the tactical duties of high level football players. In functional training, coaches will constantly increase the number of attackers and defenders in order to achieve effective control of the training. Functional training mode plays an important role in the tactical training of high level football in colleges and universities. With the help of functional training mode, it can effectively solve the problems of athletes in specific areas during the game, and

it can also achieve good communication and co-operation between coaches and athletes. The main purpose of the functional training model is to help the athlete to identify the tactical responsibilities of his/her position and to co-ordinate the relationship between the athlete and his/her surrounding players.

As the functional training mode is more focused, it will make athletes feel that the coaches attach importance to them, and will enhance their confidence and enthusiasm in training, thus helping them to overcome the various problems they encounter in the competition. Therefore, the functional training mode can cultivate the feelings between coaches and athletes, and athletes and their peers, and form a close collaborative relationship. In the process of tactical training for high level football teams in universities, the use of functional training should be strengthened. In addition, this kind of targeted tactical training can further help athletes to clarify their own tactical responsibilities through training in specific areas. However, functional training requires co-operation and collaboration amongst the team members, and the difficulty factor is higher, thus placing a higher demand on the training ability of the coaches. Generally speaking, only coaches with a high level of training foundation and ability can ensure the smooth development and implementation of the functional training mode.

Conditional training mode is one of the most important modes of tactical development of football teams, through which it is possible to complete a large number of continuous training activities, thus strengthening certain tactical skills of the entire high-level football team. Setting up certain conditions not only helps high-level football players to successfully complete training activities with specific requirements, but also enables them to effectively achieve their training goals. Coaches use the integration and regulation of training elements to change the conditions of training, thus facilitating the development and implementation of conditional training. The conditional training model has obvious integrating and regulating factors, such as the differentiated time and space of the training site.

The area, size and shape of the training area can influence the fulfilment of the training objectives. At the same time, coaches often control the size of the field, the scoring method, the incentives and penalties, the number of touches and other conditions. Through the conditioned training model, high-level football tactical training in high schools can obtain an effective training framework, so as to achieve the coordination and cooperation of the whole football team (Hagum, Tønnessen, Nesse, & Shalfawi, 2023).

Coaches and players of high level football in colleges and universities are under great pressure in matches, and in the final stage near the end of the match and when the players have reached the limit of physical exertion, the opposing team often pushes the attacking situation. Generally speaking, only a

team with strong psychological quality can overcome the pressure and easily cope with the fierce attack of the opposing team. Targeted management and training is an important channel to strengthen the psychological quality of the athletes, and nowadays, the mode of pressure training has become a favored training method of many coaches, and through a certain amount of pressure training, the resistance of the athletes to pressure can be effectively improved, and the psychological quality of the whole team can be strengthened.

The key link in the pressure training mode is The key aspect of pressure training is the effective design and adjustment of training time, so as to shorten the adjustment time of athletes and force them to complete a series of attacks and defences within a short period of time. Pressure training is different from general technical training in that the training time is controlled within three minutes, and during the training process, it is necessary to effectively adjust and control the training rhythm, training intensity and rest intervals.

The non-confrontational hypothetical training mode refers to the practice whereby coaches imagine a virtual opponent formation and allow players to practice repeatedly according to the tactics designed in advance, in which the imaginary opponent is replaced by a pole or other forms of sports props. The effect of the non-confrontational hypothetical training mode is very obvious, and more and more coaches are choosing this training mode to improve the tactical level of their teams. The disadvantages of improving the tactical level of the team through hypothetical formations are also very obvious. With the help of certain non-confrontational hypothetical training modes, it cannot effectively help the athletes to obtain things that can be applied to the actual game, and it lacks a strong practicality.

Previously, the football sector in China had become overly reliant on this mode of training, resulting in players not being able to choose the right type of tactics on their own, which had a negative impact on their tactical ability. If athletes are able to understand the content of tactics without confrontation, then a non-confrontational hypothetical training mode can be adopted. Therefore, coaches usually use the no-confrontation hypothetical training mode to train athletes to understand new tactics or new ways of playing.

2.1.2 Tactical physical training design for flat football team

For football players, their physical condition directly determines whether the tactics can be played normally and whether the tactical effects can be realised. In traditional football tactical training, the tactical training is often separated from the physical training or adopted a unitary approach without differentiating the physical training of different athletes to match the tactics. This study integrates the physical training of high-level athletes into the tactical training system. From the point of view of sports kinesiology, physical fitness

training includes body shape, physical function, sports quality and health level. As a sport with strong confrontation and high physical requirements, football has to be adapted to the athletes themselves, so that their physical abilities can meet the demands of the game through training. According to the requirements of football matches, the composition of football special physical training is shown in Figure 2.

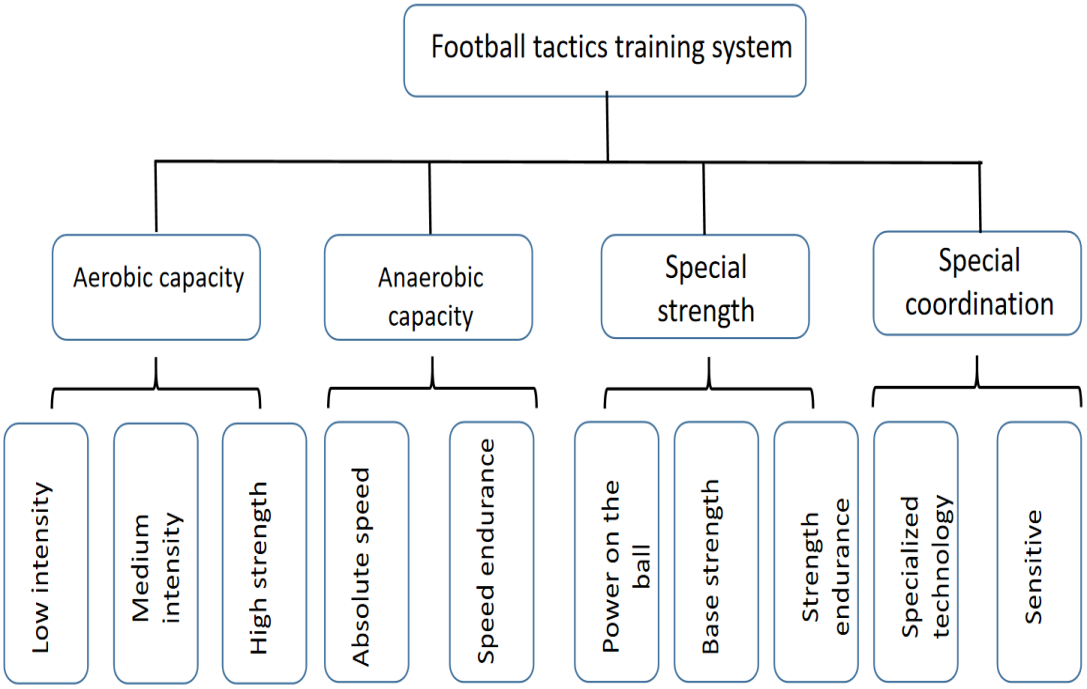

Figure 2: Schematic diagram of football-specific physical training content.

Aerobic capacity training in football includes aerobic low-intensity training, aerobic medium-intensity training and aerobic high-intensity training. Aerobic low-intensity training aims to shorten the recovery time of the body and effectively promote the development of the body itself. In practical training, we can use the continuous training method to perform mobile passing exercises; aerobic medium-intensity training aims at the recovery of the long-time athletic ability, so we can use the continuous training method to perform the bases-loading exercises; aerobic high intensity training can be used to perform the intermittent training method to perform the no-direction passing exercises or the practice of the small field.

The intermittent training method can be used to perform the intermittent training method to perform the intermittent training method to perform the intermittent training method to perform the intermittent training of the small-field game exercises; the intermittent training method is the best way for the players to perform the intermittent training. Aerobic high intensity training can be carried out by using intermittent training method to practice passing and grabbing in no direction or small field competition practice. In practice, training can be carried

out according to the operational control elements in Table 1.

Table 1: Elements of Load Control in Specialised Aerobic Performance Training for High Performance Football Players.

TYPE	AEROBIC LOW INTENSITY	AEROBIC MEDIUM INTENSITY	AEROBIC HIGH INTENSITY
TRAINING METHOD	√	√	
TRAINING RULES	√		√
GOAL ARRANGEMENT		√	√
USE BALL TYPE	√	√	
PLAYER QUANTITY	√	√	√
PRACTICE VENUE	√	√	√
LOAD COMBINATION METHOD	√	√	√
CONTINUOUS AND INTERMITTENT TIME	√		√

Anaerobic training in football specific fitness training includes absolute speed training, lactic acid production training and lactic acid tolerance training. In absolute speed training, repetition training is used for specialised sets, lactic acid production training is used in intermittent training for zone switching competitions, and lactic acid tolerance training is used in intermittent training for four-goal small field competitions. In order to control the effect of training in football-specific fitness anaerobic capacity training, it is necessary to control the relevant elements according to Table 2, so as to enhance the effect of the whole training process.

Table 2: Load Control Elements for Specialised Anaerobic Capacity Training for High Performance Football Players.

TYPE	ABSOLUTE VELOCITY	LACTIC ACID SPEED ENDURANCE	ACID SPEED ENDURANCE
TRAINING METHOD	3	26	56
TRAINING RULES	4	25	37
GOAL ARRANGEMENT	5	27	46
USE BALL TYPE	2	28	56
PLAYER QUANTITY	4	31	67
PRACTICE VENUE	7	35	46
LOAD COMBINATION METHOD	5	27	37
CONTINUOUS AND INTERMITTENT TIME	6	28	56

Another important training direction of specialised physical fitness for high-level football players is muscle strength training, in which muscle strength training includes basic strength training, transfer strength training and football strength training.

Basic strength training in football mainly adopts repetitive training method to train centripetal strength and centrifugal strength to improve muscle strength and explosive power; transfer strength training adopts repetitive training method or intermittent training method to train rapid extension and retraction or running and jumping to improve its mobility; football strength training uses repetitive or intermittent training method to train with or without the ball. Specific training control elements can be applied as shown in Table 3.

Table 3: Elements of Muscular Strength Training Control for High Performance Football Players.

TYPE	ACTION SPEED	NUMBER OF CONTACT GROUPS	STRENGTH	REPEAT TIMES
CONCENTRIC TRAINING	○	○	○	○
ECCENTRIC TRAINING	○	○	○	○
WAIT FOR LONG TRAINING	○	○	○	○
SUPER EQUAL LENGTH	○	○	○	○
RUNNING AND JUMPING TRAINING	○	○	○	○
TRAINING WITHOUT BALL	○	○	○	○
TRAINING WITH THE BALL	○	○	○	○

In the physical training, high-level football players are pre-tested in advance, and the participating high-level football players are divided into two groups according to random grouping. The experimental group undergoes strength training in different forms and proportions, while the control group High-level athletes perform strength training the same way they always have.

Before the experiment, high-level football players were subjected to special sports ability tests. The content of the test and the corresponding competitive performance are shown in Table 4.

Table 4: Specialised Athletic Performance Assessment Test Form for High Performance Football Players.

TYPE	FITNESS GOALS	SPECIAL COMPETITIVE PERFORMANCE
VERTICAL JUMP	Core strength, explosive power	kick, shoot, sprint
FOUL BALL	Speed, power, explosive power	explosive exertion during the race
SPRINT	Anaerobic capacity, acceleration power	sprint ability
ARROW SENSITIVITY TEST	Agility, acceleration	body control ability
PUSH-UPS	Core strength, endurance	confrontation ability
SIT-UPS	Core strength, endurance	confrontation
SPECIAL KICK	Speed, power, explosive power	explosive force

2.2 Proposed algorithm

2.2.1 Cascading Networks and Key point Heat Maps

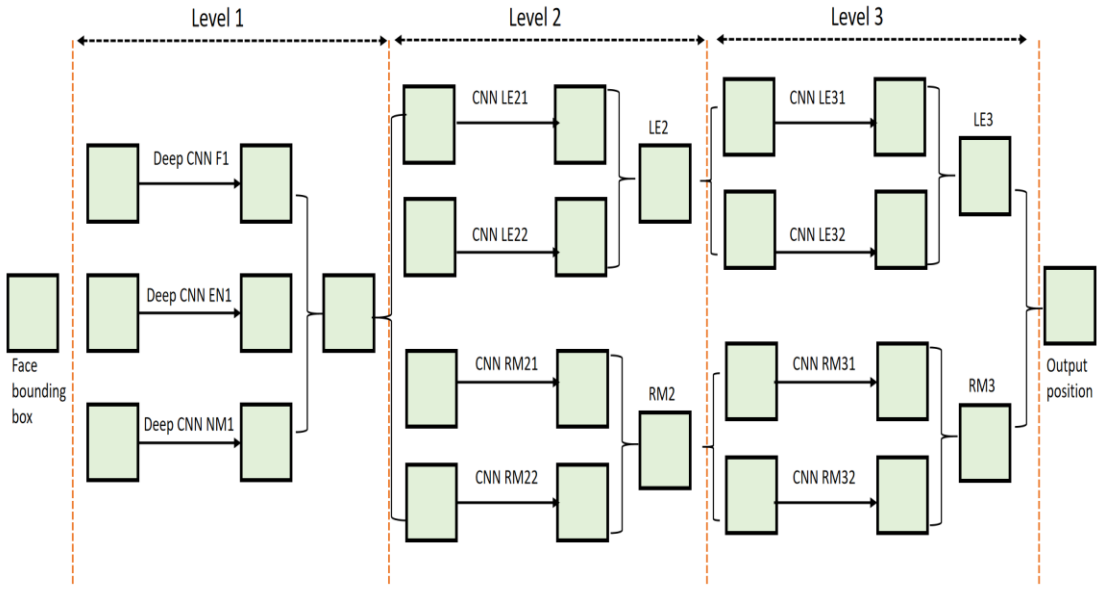

Figure 3: Schematic diagram of cascade regression network of DCNN.

The proposed cascade regression network is shown in Figure 3. With the help of CNN's powerful feature extraction capability, more accurate key point detection results are obtained. The first level in DCNN (Chen et al., 2023; Huang, Zhang, Liu, & Li, 2023) is divided into three CNNs, namely F1 (Face 1), EN 1 (Eye, Nos e), NM 1 (No s e , Mouth) . F 1 outputs the coordinates of 5 key points, EN 1 and NM 1 both output the coordinates of 3 key points, and the three sub-networks are averaged to obtain the input of the second level. The second and third levels are simply to fine-tune the rough positioning obtained

in the first level to obtain fine key point positioning. Similarly, in the field of human body key points, the first paper applying CNN to this field is a method of directly returning coordinates. The network of DeepPose (Toshev & Szegedy, 2014) is divided into two levels. First, the entire picture is used through a DNN to locate the positions of each joint point of the human body. Then, fine regression is performed on each joint, which is also a cascade from coarse to fine. Return to thought.

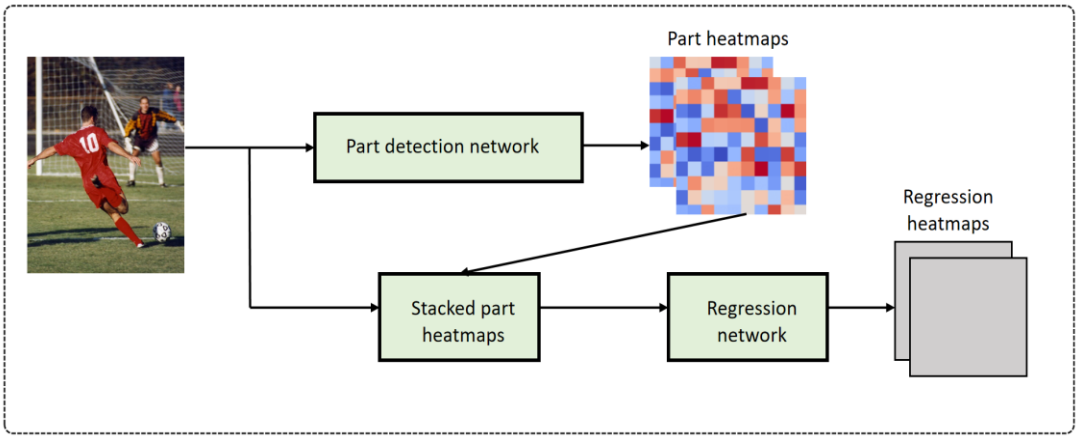

Figure 4: Schematic diagram of detection-followed-by-regression network.

Most of the methods based on deep learning after the two domains use the idea of cascade regression. For example, in 2013, FACE++ improved DCNN by dividing the key points of a face into internal key points and contour key points, and added a first-level face boundary detection box before the detection of the key points to extract the rectangular contour of the face first, and in order to further improve the accuracy, the cascade regression network integrates multi-task learning, while learning the classification problems such as whether the face has glasses, sex, and the key point detection problems of the face. To further improve the accuracy, the network of cascade regression incorporates multi-task learning, and at the same time learns the classification problems such as whether the face is wearing glasses or not, gender, etc., and the key point detection of the face (Hangaragi, Singh, & Neelima, 2023), which improves the accuracy of the key point detection of the face. Other works in the field of human key point detection have proposed a network structure that consists of a cascade of detection and regression. While detection-followed-by-regression separates detection and regression into two independent networks, its regression sub-network also uses the heatmap of the whole picture fusion detection network as input, which can better utilize the heat map of the fusion detection network as input. The structure of the network is shown in Figure 4, which can make better use of the context information.

2.2.2 Ground Truth

The label input to the neural network is also called Ground Truth, which

is the true label of the training samples input in supervised learning. In the field of key point detection, there are two main ideas for constructing Ground Truth: coordinates and Heatmap. The coordinates directly use the coordinates of the key points as the final return target of the network. MSE is often used as the loss function. In this case, the position information of each coordinate can be obtained directly. Heatmap uses a probability distribution map to represent each type of coordinates, and gives a probability to each pixel position in the picture, indicating the probability that the point belongs to the key point of the corresponding category. What is more commonly used is that the probability of pixels closer to the marked position of the key point is closer to 1, and the probability of pixels further away from the key point is closer to 0. Specifically, it can be simulated through the function:

$$M_i(x,y) = \frac{1}{\sqrt{2\pi\sigma}} \exp\left(-\frac{D_i(x,y)^2}{2\sigma^2}\right) \quad (1)$$

Heatmap's Ground Truth provides supervisory information to each pixel point, which reduces the non-linearity of the regression problem, and achieves fast convergence with high accuracy.

2.3 GAN

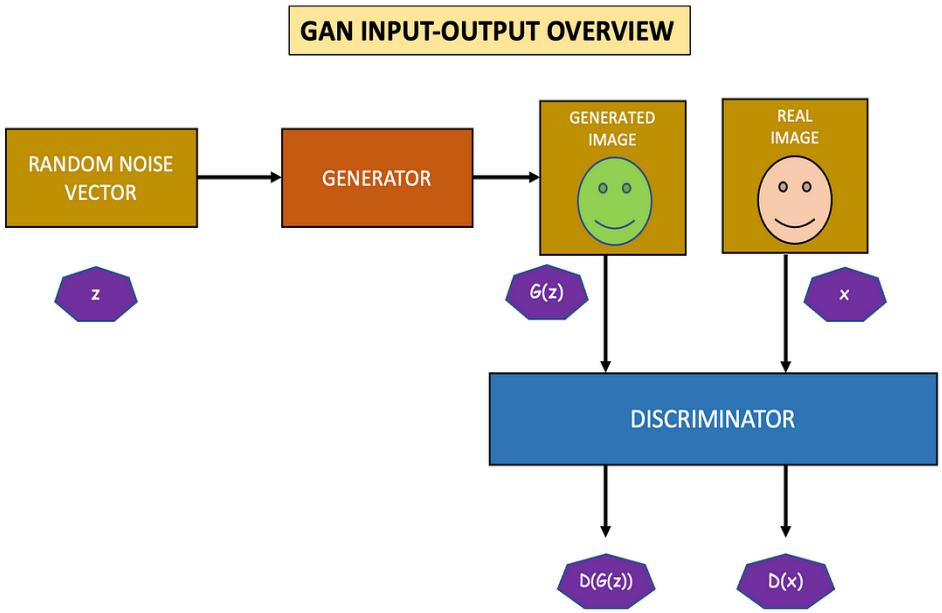

Figure 5: Structural diagram of the GAN.

When doing key point heatmap regression, MSE is usually used as the loss function, but minimising MSE usually results in the network converging to a fuzzy and unrealistic heatmap, which makes it difficult to train the network correctly, and can be called regression-to-the-mean. We can judge the realism

of the heatmap generated by borrowing from the training methods used in the generation of adversarial networks. We can refer to the training methods in the Generative Adversarial Network to judge the authenticity of the generated Heatmap. The Generative Adversarial Network (GAN) is a generative model proposed in 2014. The core idea of GAN comes from the Nashian balance in game theory, which sets the generator and the discriminator as the two parties participating in the game.

The generator aims to fit the real data distribution as much as possible, while the discriminator aims to correctly determine whether the data it receives comes from real data or from the generator. In the course of the game, both players keep optimising themselves, improving their own generating and discriminating abilities, and finally obtaining a generator that generates "fake" data, the structure flowchart of which is shown in Figure 5. Training GAN usually uses the alternating optimization method. Under the given generator G, the optimal discriminator D usually uses the cross entropy function as the loss function, and its calculation equation is as follows:

$$loss_D = -\frac{1}{2}E_{x\sim P_{data}(x)}[\log D(x)] - \frac{1}{2}E_{z\sim P_z(z)}[\log(1-D(G(z)))] \tag{2}$$

where x is sampled from the true distribution, z is sampled from the prior distribution $p_z(z)$, and its equation can also be defined as:

$$\begin{aligned} loss_D &= -\frac{1}{2}\int p_{data}(x)\log D(x)dx \\ &-\frac{1}{2}\int p_z(z)\log(1-D(G(z)))dz \\ &= -\frac{1}{2}\int[p_{data}(x)\log D(x) + p_g(x)\log(1-D(x))]dx \end{aligned} \tag{3}$$

It can be seen that GAN is the ratio of the two estimated probability distribution densities.

$$\frac{P_{data}(x)}{P_{data}(x)+p_g(x)} \tag{4}$$

For the discriminator D, when the input data is data sampled from the real distribution, the output of D should approach 1, and when the input data is the generated data $G(z)$, the goal of D is to make D(G(z)) approaches 0. When the goal of G is mentioned above, D(G(z)) approaches 1, then the loss function of the generator G is $-loss_D$. Therefore, the objective function of GAN can be described as:

$$\min_{G}\max_{D}\left(f\left(D,G\right)\right)=E_{x\sim P_{data}(x)}\left[\log D(x)\right] + E_{z\sim P_{z}(z)}\left[\log\left(1-\mathrm{D}\left(G\left(x\right)\right)\right)\right] \quad (5)$$

Training GAN usually uses an alternating optimization method: first, fix the generator G, optimize the discriminator D, so that the accuracy of the discriminator is maximized, then fix the discriminator D, optimize the generator G, so that the accuracy of D is minimized. When training GAN, in an alternating parameter update, the parameters of D are generally updated k times and the parameters of G are updated once.

3. Experiment and Results

3.1 Datasets

Video resources of football matches can be easily obtained from the Internet. The data of this paper is collected from real live videos of football matches on the Internet. We crawled 98 football match videos in three times, with a total video duration of about 90 hours. In order to meet the project requirements, the crawled videos are all of 720p resolution. After obtaining the video resources, we use OpenCV to extract frames from the collected videos to obtain pictures.

In order to ensure the non-repetition rate of the pictures obtained by extracting frames, we set the interval of extracting frames to 10 seconds, and obtained about 3. There are 30,000 original pictures, and the picture sizes are all 720*1280. The key point detection project of the football field is mainly to provide location information for more complex football video understanding projects. In order to achieve the project goals, we need to select positions that have obvious characteristics and can provide location information and define them as key points of the football field. Figure 6 is a top view picture of a standard football field. Its width and height are 1100 and 700 respectively. The football field has natural divisions and white line marks. We will define key points on this top view.

Since the project is in the early stages of research and will continue to be studied in the future, this paper does not elaborate on the detailed definition of key points here, but only explains how the key points are defined. We defined N key points on the top view shown in Figure 6, which are distributed in areas such as the court boundary, penalty area, small penalty area, center circle, penalty kick point and goal. The selection of key points first needs to meet the conditions that the human eye can clearly identify under different viewing angles, so that the neural network can learn and locate. Therefore, it is meaningless to define key points in an empty part without any reference objects. At the same time, the key points also need to meet the condition that the physical position does not change.

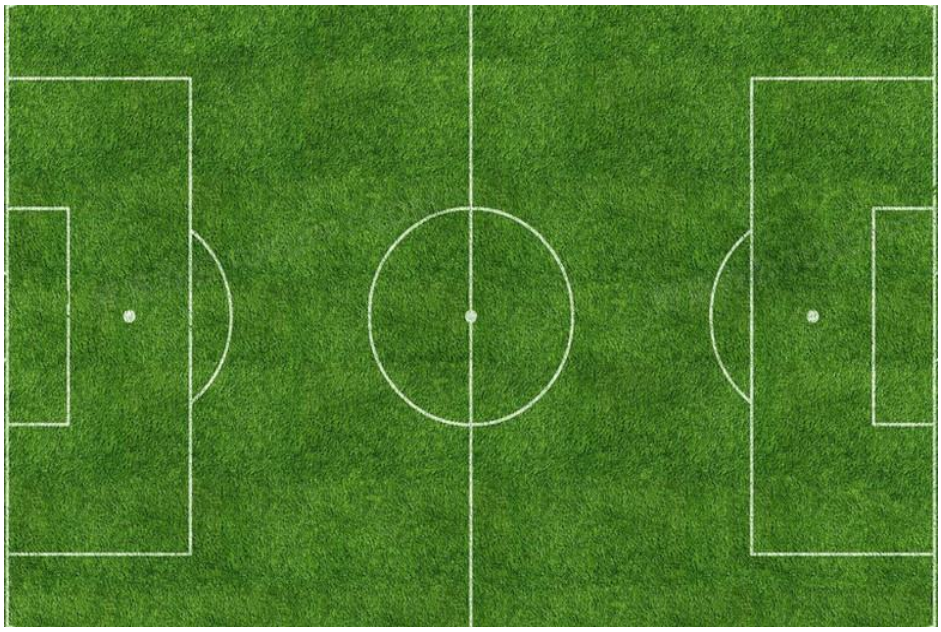

Figure 6: Top view of a football pitch.

3.2 Experimental setup

The server used in this paper is loaded with two NVIDIA GeForce GTX 1080 with 8GB of video memory. The models in this paper were trained on this software. The server system used in this article is the 64-bit Ubuntu 16.04 version. The server is based on a 64-bit Ubuntu 16.04 version, with a 390.67 VGA driver and a CUDA version. The server is running on a 64-bit Ubuntu 16.04 version with a 390.67 graphics driver and a 9.1 CUDA version, as shown in Table5 and 6.

Table 5: Experimental environment setup.

TYPE	PARAMETERS
OS	Ubuntu 16.04
GPU	Nvidia GTX 1080 (8G)
RAM	16G
PYTHON	3.6.5
TRANSFORMERS	3.0.2
PYTORCH	1.4.0

Table 6: Hyperparameter settings.

HYPERPARAMETER	VALUE
BATCH_SIZE	32
DROPOUT	0.4
OPTIMIZER	Adam
LEARNING RATE	3e-5
EPOCH_NUM	2000

3.3 Experimental results and analysis

In this experiment, the design plan mainly focused on tactical training. However, considering that there is a close relationship between the athletic ability demonstrated by physical training, the performance of tactical skills, and the achievement of tactical goals, some tactics-related training was incorporated into the experiment. physical fitness items and analyze their physical fitness test results before the experiment. The experiment selected items such as vertical vertical jump, 5*30-meter sprint, arrow change direction run, 30 seconds push-ups, 60 seconds sit-ups, foul ball throwing and special long kick as physical fitness test items. These projects are mainly to indirectly understand the instant acceleration level, endurance level, agility, explosive power and other physical abilities of high-level athletes. For example, from the vertical jump data, we can understand the rapid strength level of high-level football players; from the arrow change direction The agility of high-level football players can be understood by running; the endurance level of high-level football players can be understood from the data of 30-second push-ups, etc. The data of these items were tested before the experiment, and the data between the experimental group and the control group were obtained respectively. These data were analysed. The analysis results showed that the P value of each item category was greater than 0. 05, indicating that there is no significant difference in physical fitness between the two groups of high-level athletes, as shown in Table 7.

Table 7: Pre-experimental high-level football team Results of physical fitness tests of the experimental group and the control group.

TYPE	CONTROL GROUP	EXPERIMENTAL GROUP	P
VERTICAL JUMP	2.21	2.20	0.843
FOUL BALL	22.83	22.78	0.821
SPRINT	17.40	17.52	0.862
ARROW SENSITIVITY TEST	28.21	28.42	0.873
PUSH-UPS	51.19	51.24	0.798
SIT-UPS	22.45	22.53	0.815
SPECIAL KICK	52.18	52.07	0.824

Before the formal implementation of the experimental plan, a statistical analysis was conducted on the football matches of the experimental group and the control group, in which the data on influencing factors related to the technical results were recorded, and the differences in skills between the experimental group and the control group were understood through comparison. When observing the number of shots taken by the experimental group and the control group, it was found that the total number of shots taken by the experimental group and the control group was equal, which also indirectly

shows that the difference in skill level between the two is not very big.

From the analysis of the number of attacks, the number of attacks between the experimental group and the control group was also 12 times, which shows that the two groups have equal offensive coordination. From the comparison of the number of passes, the number of successful passes, the number of failed passes and the pass success rate, it can be found that overall the control group has a higher pass success rate than the experimental group, but the difference is not Very big. From the comparison of the running distance data of the experimental group, it can be seen that the high-level athletes in the experimental group have a certain ability to return and can quickly accelerate back and forth or change directions in football matches. Judging from the number of times it entered the opponent's penalty area, the experimental group was higher than the control group. This shows that the experimental group has a strong offensive ability. It also proves that the control group is weak in defense. There is still room for further improvement in the use of tactics. In general, there is not a big difference in the overall competition level between the experimental group and the control group. Two different groups can be used for experimental comparison.

Tactical awareness is the most important part of tactical training and is also the prerequisite for achieving tactical goals. In the study, the content of tactical awareness was identified as sport-specific intuition, sport-specific attention, sport-specific memory, sport-specific role, football tactical knowledge and football skills. Any dimension in the tactical awareness system may have a certain impact on the execution of tactics. For example, the tactical awareness of parts is directly related to the integrity of the football team, and the tactical awareness of overall coordination is also directly related to the offensive and defensive capabilities of the entire football team. wait. In the experiment, a questionnaire was designed based on the content structure of tactical awareness and distributed randomly to collect the cognitive status of tactical awareness between the experimental group and the control group. The specific survey results are shown in Table 8.

Table 8: Tactical awareness test results of the experimental group and the control group of the former high-level football team.

TYPE	CONTROL GROUP	EXPERIMENTAL GROUP	T	P
INTUITION	3.445	3.542	0.235	0.743
ATTENTION	3.841	3.783	0.321	0.728
MEMORY	4.652	4.532	0.212	0.849
ROLE	3.592	3.672	0.176	0.872
TACTICAL KNOWLEDGE	3.785	3.832	0.153	0.815
SKILLS	4.136	4.321	0.148	0.853

Physical training is the main training content required for high-level football players. Generally speaking, physical training is isolated from tactical training. Athletes develop their physical fitness in a fixed form or even a fixed model, showing physical training and tactics. The situation of two skins ultimately led to the mobilization of his physical fitness level during actual tactical exercises. This point was emphasized in the experiment, which is to combine tactics to improve physical fitness. In particular, this experiment has designed targeted training methods for athletes' physical shortcomings that often occur in competitions. After the experiment, the physical fitness items that were tested before the experiment were back-tested. After the experiment, the vertical jump, 5 * 30-meter sprint, arrow change direction run, 30 seconds of push-ups, 60 seconds of sit-ups, The P values in the throw-in ball throwing and special long-distance kicking projects are all less than 0. 05, indicating that the results showed a significant difference, and in the comparison, it can be seen that the results of the experimental group after the experiment were significantly better than those of the control group. This can prove that the physical fitness test plan adopted in the experiment is effective, as shown in Table 9.

Table 9: Post-experimental results of the physical fitness tests of the experimental group and the control group of a high-level football team.

TYPE	CONTROL GROUP	EXPERIMENTAL GROUP	P
VERTICAL JUMP	2.25	2.38	0.024
FOUL BALL	22.36	21.86	0.016
SPRINT	17.23	16.96	0.017
ARROW SENSITIVITY TEST	28.56	29.32	0.027
PUSH-UPS	51.21	52.54	0.031
SIT-UPS	23.45	23.53	0.015
SPECIAL KICK	53.19	53.37	0.004

4. Conclusion

In this paper, we develop a football team tactical optimization and opponent analysis model based on big data mining and machine learning. Specifically, the two-level cascaded convolutional neural network of detection and regression in the model adopts the classic ideas in face key point detection and human body key point detection: the idea of cascade regression is used to determine the location of key points from coarse to fine. Detection; use the key point heatmap detected by the first-level network as supplementary information to perform feature fusion with the original image; the second-level regression network uses Heatmap with better results as the Ground Truth of the network, providing pixel-by-pixel supervision for key point locations. The regression and prediction of whether key points are visible. This paper combines the idea of adversarial learning to design a loss function to solve the regression-to-the-

mean fuzzy problem when regression Heatmap. The second-level network is used as the generator, the discriminator is designed, and the loss function is defined to judge the reliability of the generated Heatmap. . Through the adversarial learning training method, the second-level network converges, predicts a reliable Heatmap, and then obtains key point coordinates to identify opponents to optimize football team tactics. The final simulation experiment results also prove the effectiveness of the proposed model.

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