Problem Chosen	2020	Team Control Number
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Teamwork Analysis From Football to Society

In order to search for the best strategy for teamwork, we first establish the **Compactness Model Based on Passing (P-C Model)**,with the assistance of which we successfully establish the Dynamic Compactness Network for passing between players. The network is able to reflect the directional connections between players on the field in real time, thus making it possible to provide a lot of information such as network model,personal tactical value, team strategy and so on.Taking advantage of this network and previous research and data, we establish the **AODC Model** which help us summarize four performance indicators of teamwork and the evaluation factors of each performance indicator which can judge the relationship between team strategy and opponent strategy and the nature of the team itself.

In the P-C Model, we establish multiple sub-models and indicators for the final Dynamic Compactness Relationship Network.We quantify the impact of each passing on player relationships to construct the Real-time Compactness Function so as to be able to reflect the compactness between players.For the sake of being able to identify the network model and reflecting the team's team strategy over a period of time, we modified this function and proposed the Compactness Function.Considering the impact of individual abilities on the team , we put forward the Player Ability model to judge the value of players in the team's strategy. Next, we predict the player's movement direction and speed on the court, and successfully use Matlab to simulate the movement of all players on the court to form real-time motion trajectories.Eventually, we use the movement position as the position of the node, and the Compactness between the two as the weight of the arc, and establish a dynamic closeness relationship network, which can draw the current network relationships of the team's current strategy and tactics, and the connections between players.

In the AODC model, we select four performance indicators that reflect successful teamwork.Under the Pareto's Law ,We select a limited number of representative factors, and analyze values of these factors from the data .Owing to the fact that dimensions of each factor value are different, we normalize each factor value.We use the Analytic Hierarchy Process to construct the coefficient matrix. After calculating the weight value of each factor on the performance index,we calculated the performance index scores of multiple teams including the Huskies, which not only verified the accuracy of the model, but also reflected the Husky team's ability in four aspects this season.Focusing on adaptability and comparing the other three performance indicators of the opposing team, we can understand the team's ability to respond to strategic changes, and propose that the effectiveness of the strategy is related to the anti-strategy to a certain extent.

Finally, based on the above two models, we establish 6 evaluation criteria for the Excellent teamwork, and give a method for designing and evaluating teams with models, and proposed data that needs to be captured in order to develop a general model of team performance. As a conclusion, we write a letter to the management of the Eskimo team and provide opinions based on our analysis of the team .Apart from this, We wrote an extremely complicated program to get the offensive heat map of the Huskies team this season, through whitch the management can more clearly find the internal problems of the team.

Key Words:real-time motion trajectories, Dynamic Compactness Network, Analytic Hierarchy Process, offensive heat map throughout the season.

Contents

1 Introduction

1.1 Restatement of The Problem

Teamwork is an integral part of human society's progress.And it is an important aspect of the success of people in today's society.The tacit cooperation of many people with different talents is one of the reasons for the rapid development of science, culture and art.Competitive team sports is a typical teamwork activity.Its victory depends not only on individual abilities, but also on the way the players cooperate.Throughout the competition, good collaboration and Coordination played an important role in winning the victory.Therefore, we believe that the key to a team's effectiveness lies in its ability to form good cooperation.

In this partnership,there should be multiple cooperation strategies and relationships that directly or indirectly affect the final result.We can study the positive interactions and winning factors among players in a team that can help win,and help teams such as the Huskies to find their strengths and increase their strength.Establishing a collaborative approach that enables teams to operate efficiently is critical to team development. Here, we are required to design a series of models to guide teamwork in Huskies.

We mainly need to achieve the following four goals.First,establish a dynamic network of relationships between players, team formation, and player personal abilities. Use the created network to identify network patterns and other network attributes.At the same time,other indicators of links between teams should be discussed.Second, determine the indicators for achieving excellent cooperation, and discuss the pertinence and generality of the strategy.Use these indicators to create models to capture the structure, configuration, and more of teamwork.Third, discuss the excellent teamwork strategies for Huskies through the established model,and make reasonable suggestions on how to optimize the team.Finally, a more effective design for teamwork in society should be summarized from the established model.And understand the underlying causes of team superiority and legitimacy.It also discusses the factors that need to be captured in order to achieve this goal.

1.2 Literature Review

By consulting the literature, we know the following points:

• The sequence of passes is related to the number of passes and the number of passes.[1]

• In order to capture the influence of a given player in the game, we build a "ball flow" directional network among the players of the team. In this network, nodes represent players, and arcs are weighted based on the number of passes successfully completed between two players.[2]

• A set of performance indicators based on the pass is extracted from the observation data of the football game and summarized as the H indicator. We observe a strong correlation between the proposed metrics and the success of a team.[3]

• Increased network strength leads to improved team performance, and increased network concentration leads to reduced team performance[4]

1.3 Our Work

Our task is to explore a reasonable and effective team strategy. To achieve this goal, we have established two main models: **Compactness model based on passing (P-CM)**, **AODC model**. We also built the **Excellent teamwork model** based on the above two models.

In Compactness model based on passing (P-CM), our ultimate goal is to establish a dynamic network of close relationships. This model captures the **Compactness** between players and their real-time position on the court. First, we quantified the impact of passing on the relationship between players, and proposed the **Passes Index** and the **Passing Distance**

Index. Second, in order to be able to consider the impact of these two indicators at the same time, we proposed the **Real-time Compactness Function** to reflect the Compactness between players at the current moment. We also want to know the strategy and tactics of the entire team for a period of time, so we have made targeted corrections to the Real-time Compactness Function.Third, we built a **Model of player ability**. This model can help us measure the player's personal ability and his tactical position in the team, so as to judge whether he played a positive or negative significance for the team.Fourth, we predict the player's movement trajectory according to the adjacent position and time of each player, so as to simulate the **real-time distribution map of players** on the court.Finally, we established a **Dynamic Compactness Network**, which can map the team's current strategic tactics, player relationships and other network relationships in real time. We set the threshold and compare with the passing ability to identify the current network mode, analyze the movement of the court, and give the appropriate team strategy.

In the AODC model, in the first step, we summarize four performance indicators that reflect successful teamwork: **Adaptability, Offensive, Defensive, and Coordination**.In the second step, in order to measure these four indicators, we follow the Pareto rule from many factors to select a limited number of representative factors and extract the values of these factors from the data of 38 games.In the third step, we normalize the values of these factors with different dimensions. We normalize the results of these factors and establish an equation with the scores of each performance indicator.In the fourth step, we use the A**nalytic Hierarchy Process(AHP)** to calculate the weight value of each factor, and calculate the score of each performance indicator based on these weight values.Finally, we randomly select a set of data from the authoritative football websites, use this model to analyze, and compare the results of the analysis with the actual situation to evaluate our model.

Based on the above two models, we give a method of designing effective teams named the **Excellent teamwork model**.In the Excellent teamwork model, first, we correspond and extend the factors in the P-CM model and the AODC model to the factors of team activities that exist widely in society, thereby defining six aspects for evaluating and designing efficient teams,and unify them.

In the end, we wrote a complicated program to get the offensive heat map of the Huskiesthis season.As a conclusion, we put forward opinions about the team's strategy to the management of the Husky team based on the figure and the results of the analysis of the above models.

2 General Assumptions

Due to the lack of some data, we cannot accurately restore the condition of the stadium. The reasons that make some groups better than others are more complicated, and may be caused by many deep-seated reasons.Based on the above reasons, in order to simplify the problem, we propose the following assumptions:

- It is assumed that all 38 games are played normally, and no situation such as the general is injured, or one of the two sides of the game intentionally loses.
- Assume that the given coordinate positions in the data are the position of the Origin Player and the position of the Destination Player. Since the player position is very important for us to judge the form of the game, and most of the players are around the ball when the event occurs, we can determine the position of the ball, that is, the position of the player.
- Assume that the player's movement on the court is approximately straight. From the data point of view, we cannot get the current position of the player, so in order to simulate the player's movement on the court, we can approximate the player's movement on the court as a straight line.

- It is assumed that when the possession of the ball changes, it means that the player who received the ball failed the pass.
- Assume that the Compactness between players will not change due to off-court factors between players, eliminating interference from uncertain factors outside the field.

3 Compactness Model Based on Passing（P-C Model）

3.1 Basic Structure of The Model

In the P-C Model,We have developed multiple methods.In order to simulate the current position of the players on the court with this model, a dynamic network of Compactness was established for real-time display of various network attributes such as compactness between players, pitch formation, player capabilities, etc.

Table 1: Notation

Symbol	Description
$T_{current}$	The current moment of the game
$t_{(i,j)}$	Moment when i player passes j player
λ_{pass}	Coefficient of Pass factor
$k_{distance}$	Attenuation coefficient of pass distance indicator
$dis_{(T_{current},\ i,\ j)}$	Distance from i player to j player before the current moment
$N_{(T_{current})}$	Total number of passes by the team before the current moment
$N^{(i)}_{successful}$	Number of successful passes by player i throughout the game
$N^{(i)}_{failed}$	Number of failed passes for player i during the entire game
$Ave\_N^{(i)}_{(T_{current})}$	The average number of passes from player i to each teammate
$N^{(i,\ j)}_{(T_{current})}$	Total number of passes made by player i to player j before the current moment

- **Step 1**: We use two indicators to show that compactness is related to passing distance and passing time.These two indicators can quantify the connection that each pass brings to the two players.At the same time, when two or three people cooperate closely on the football field, the passing time is short and the distance is short. Therefore, we think that these two indicators will decrease with the increase of time and distance.In order to facilitate programming, we store the time, distance, team and other parameters of each pass in the form of a Cell Array and visualize them.Figure n shows the impact of the two indicators. From the figure, it can be concluded that the two indicators have certain similarities.
- **Step 2**: We build a model of the player's Passing Ability.Due to the limited data given, we do not know the position distribution of opponents when the Huskies players pass.Therefore, we use the Weighted Average Method to propose a player's Passing Ability model.The individual's Passing Ability and the Compactness between the player and other players are used to reflect whether the court's strategic tactics are reasonable.
- **Step 3**: We optimized the Relational Precision Model.The indicators of the number of passes and the distance of the passes are related to the Relational Precision,and the above two indicators can only judge the Compactness and network mode between players at a certain moment.Therefore, we have optimized the Relational Precision Model so that it can simultaneously reflect the combined effect of the two indicators and the Compactness between players in a certain period of time.
- **Step 4**: We calculate the approximate speed and direction of the player's movement through the positions where the player appears twice in a row.Matlab simulates the real-

time position and trajectory of players on the court to determine the formation of the court.At the same time, a Dynamic Compactness Network is established, where the network nodes represent players, the node positions represent the current moment formation, and the arcs are directed lines, which indicate the compactness between players.This kind of network diagram allows us to code a large number of individuals and groups and intuitively reflect many problems in team strategy.

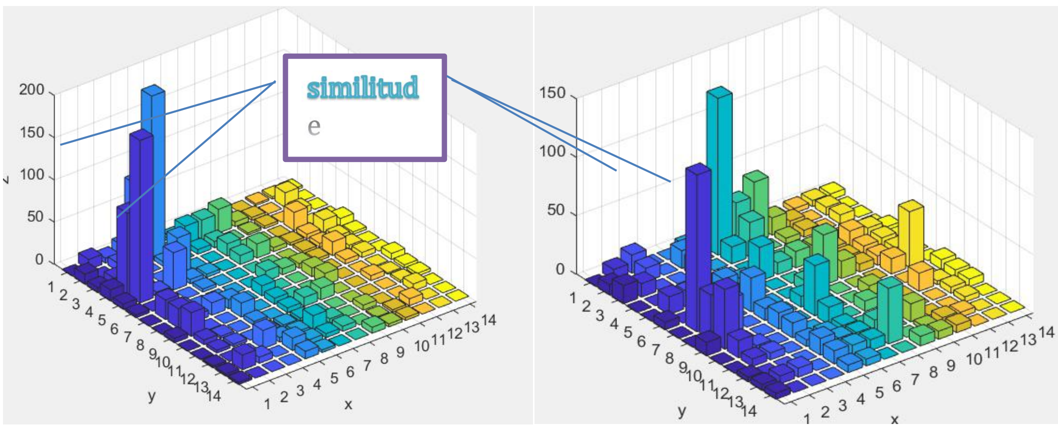

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Figure 1: Compactness indicator in the first half of the first game

3.2 Compactness Indicator

In football, the core of teamwork is to establish effective connections between players, but this connection is abstract.Therefore, we propose Compactness Indicator to quantify the impact of each pass. At the same time, this indicator is also affected by time and distance.Considering that the passing is directional, there is also a direction for the compactness indicator, from the Origin Player to the Destination Player.

Back to our question, to create a network between players.In order to enable this network to identify network patterns and reflect the team's current strategic tactics,we determine the position of the node by judging the approximate direction of movement through the position and time of two adjacent passes. The strength of the arc of the network based on the distance and time of the passing between the two,The specific diagram is shown in the following figure.We count and calculate specific parameters in the AODC Model to obtain two important compactness indicators.

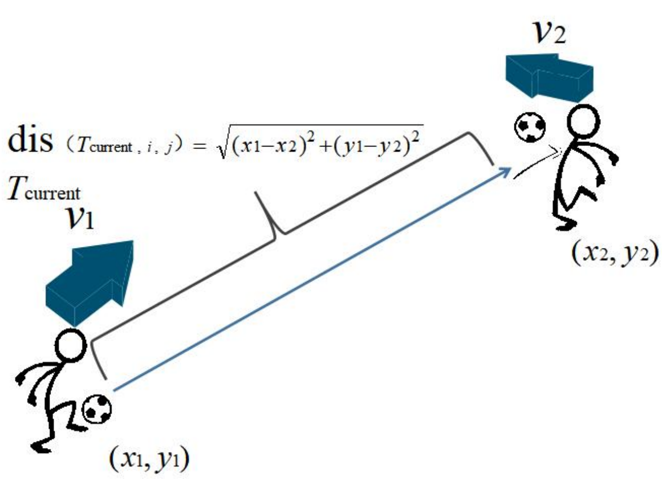


Figure 2: Schematic of Compactness Indicators

3.2.1 Passes Index

On the court, each pass of a player reflects the close connection between the players. When multiple players cooperate, the ball is transmitted multiple times, and the connection will be closer.But the occasional pass is not equivalent to dyadic and triadic configurations, so we add time to the number of passes factor, and the influence of this pass will become weaker and weaker over time.

$$Pass_i = e_{pass}^{\left(1-\frac{(Tcurrent - t(i,j))}{\lambda_{pass}}\right)} \quad (0< \lambda_{pass} <1)$$

In a football game, there will be multiple cooperation methods and multiple passes, so we need to add up these passing times factors that decay over time to get the number of passing indicators:

$$C_{pass} = Pass_1 + Pass_2 \cdots Pass_n = \sum_{i=1}^{n} Pass_i$$

3.2.2 Pass Distance Index

In order to simplify the problem, the passing distance should be as short as possible when cooperating between multiple players. In the actual game, short pass is also the main way of passing.So we can think that the shorter the passing distance, the better the Compactness between the two.Since the number of passes has been brought into the concept of time, it can be ignored here.**The Passing Distance Factor** can be calculated using the following formula:

$$Dis\tan ce_i = e^{(1-dis(Tcurrent,i,j)/k_{dis\tan ce})}$$

For the passing distance indicator, the effect of each passing distance factor needs to be recorded to obtain the passing distance indicator:

$$C_{dis\tan ce} = Distacne_1 + Dis\tan ce_2 \cdots Dis\tan ce_n = \sum_{i=1}^{n} \text{Distance}_i$$

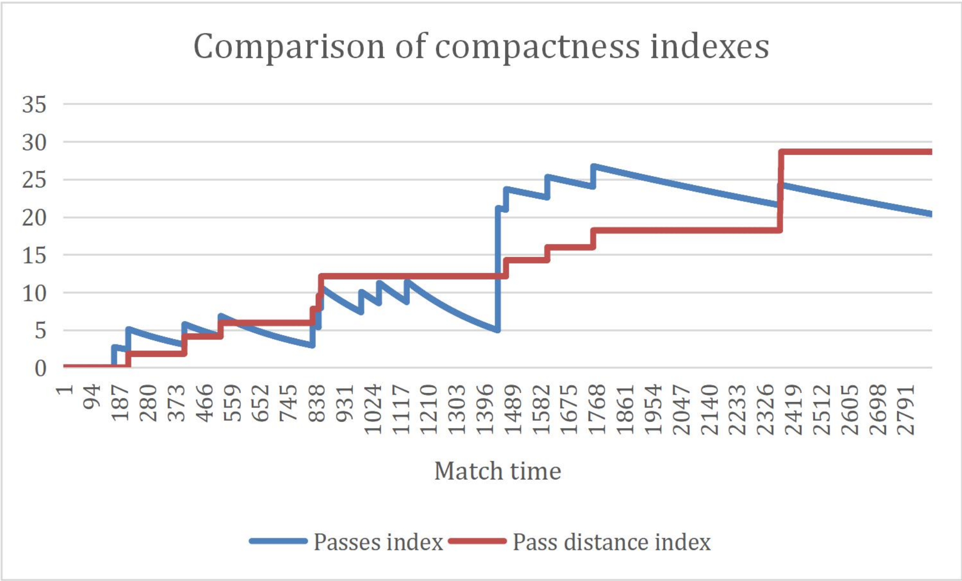


Figure 3: Match 6 Comparison of the Compactness Indicator of D2 to D6

In order to further show the impact of these two indicators, we randomly extracted the Compactness Indicator between the two players in the march 6.It can be seen from the figure that both the Passes Index and the Pass Distance Index have a step when a pass occurs.But as time progresses, the Passes Index will decay, and the Pass Distance Index will follow Add up one by one.These two indicators show the effects of two different factors, but they are both related to the Compactness Indicator.Therefore, in the following model optimization, the relationship between the two indicators and the Compactness Indicator will be derived.

3.3 Model of Player Ability

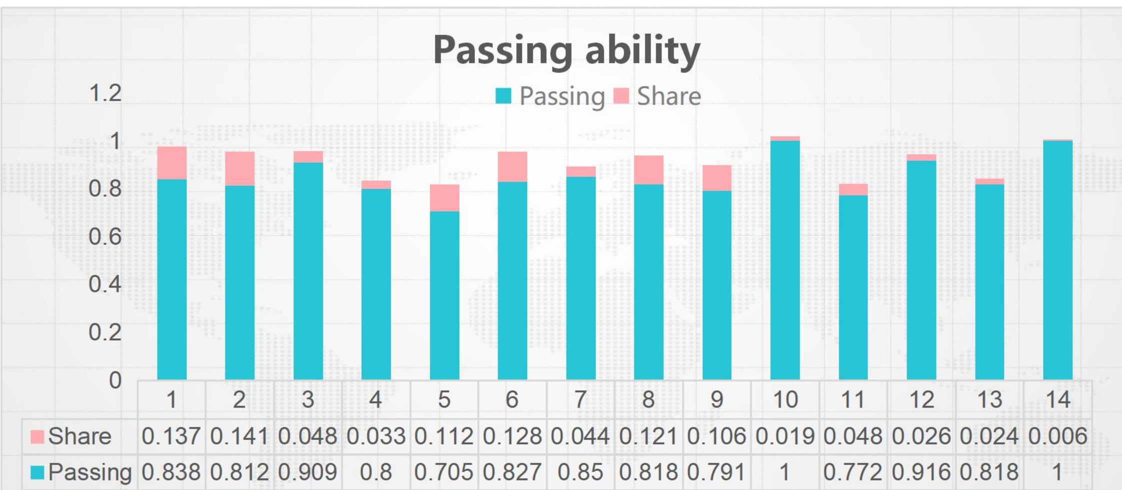
In the Compactness Indicator, due to the limited data, we only consider the influence of teammates.However, due to the different opponents, the compactness between the two people is still different, so we need to consider **the Passing Ability** of different players:

$$Passing = \frac{N_{\text{successful}}^{(i)}}{N_{\text{failed}}^{(i)} + N_{\text{successful}}^{(i)}} \bullet 100\%$$

Considering that a good player may get more passing opportunities and more passing failures, some people with fewer passes may have higher Passing Ability. Therefore, we define **the Passing Opportunity Share** here. People with less passing opportunity share are not taken into consideration.

$$Share = \frac{N_{\text{failed}}^{(i)} + N_{\text{successful}}^{(i)}}{N_{(Tcurrent)}} \bullet 100\%$$

The **Figure 4** is a statistical chart of players' Passing Ability and Passing Opportunity Share.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Share	0.137	0.141	0.048	0.033	0.112	0.128	0.044	0.121	0.106	0.019	0.048	0.026	0.024	0.006
Passing	0.838	0.812	0.909	0.8	0.705	0.827	0.85	0.818	0.791	1	0.772	0.916	0.818	1

Figure 4: Statistics of Passing Ability

As can be seen from the above figure, some players play a more important role in the game, but their abilities are not satisfactory.Therefore, the Huskies may consider reducing the number of passes for these players and reducing their position in the team strategy.

3.4 Model Optimization

the Passes Index is negatively related to time, and the Pass Distance Index is negatively related to distance.In order to judge the network model and other team cooperation strategies of members in the dynamic close relationship network based on the compactness between two players, we propose the compactness in the Compactness Model Based on Passing (P-CM). We believe that the cooperation in football is mainly composed of fast, short-range conductive balls. Therefore, we propose **the Real-time Relational compactness Function**:

$$C_{\text{Real-time}}(C_{pass}, C_{distance}) = C_{pass} \bullet C_{distance}$$

The data in the formula has been processed. After each pass, the growth range of the two parameters is [1, e]. There is no difference in strength between the two indexes. The Real-time Relational compactness Function can be regarded as a weightless function deal with.

In the actual game, the two players have a close relationship at a certain moment. It can only be considered that at the current moment, the playing field requires the cooperation of two players.However, the coach's strategic tactics will make some players more frequent contact, which is reflected in the close relationship between the two in the entire game.We hope to identify network patterns and discover more network attributes in this way. So we propose **the Compactness Formula**:

$$Compactness = \int_0^{T_{current}} C_{\text{Real-time}}(C_{pass}, C_{distance})dt = \int_0^{T_{current}} C_{pass} \bullet C_{distance} dt$$

By accumulating the effect of the compactness of the relationship at each moment, we can understand the compactness between the two players throughout the game.

However, in actual games, some teams hope to obtain a lot of Offensive opportunities through the passing ball. This will make the value of the Compactness Formula high in the whole team, and the corresponding team mode cannot be judged by the threshold. We modify the compactness formula to:

$$Compactness = \frac{N_{(T_{\text{current}})}^{(\text{i, j})}}{Ave\_N_{(T_{\text{current}})}^{(\text{i})}} \bullet \int_0^{T_{current}} C_{pass} \bullet C_{distance} dt$$

This improves the Adaptability of the compactness formula. We put the value of compactness between players in a 14 * 14 matrix, and get closer players by setting thresholds.Then determine whether it is dyadic or triadic configurations and team formations by the compactness of direction.As shown in the **Figure 5** below, assuming that the four compactness in the figure all meet the threshold, you can determine that players 1, 2, and 3 are triadic configurations and players 1, 4 are dyadic configurations.

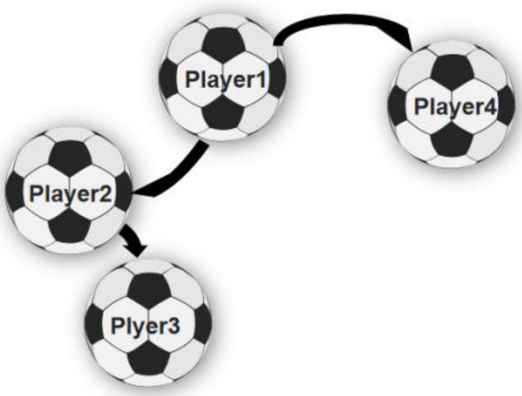


Figure 5: Network mode diagram

3.5 Dynamic Compactness Network

Considering the directional nature of the pass, this network is a typical directional network. At the same time, considering the real-time changes in the playing field, we take dynamic information into consideration and establish a complete Dynamic Compactness Network.In this network, the arc represents the relationship between the two. A cell array is used to store the compactness of the passing between the players. The nodes represent the current position of the players. These two sets reflect the course movement in real time as the time changes.

3.5.1 Establishment of Dynamic Compactness Network

In the data given, there is no real-time dynamic position of the players. We assume that the player moves in a straight line between two adjacent intervals, and calculates the player's movement speed and direction from the time difference and distance difference between the two times. In this way, we can judge the current formation on the pitch and analyze the real-time motion trajectories of both sides on the pitch. At the same time, we show the compactness of passing between players on the field in real time, so that we can capture the current network model among players, the team's structural, and so on.

In order to be able to visually display the dynamic model, we take a network diagram at a certain moment in the second half of march 1. As **Figure 6,7** .

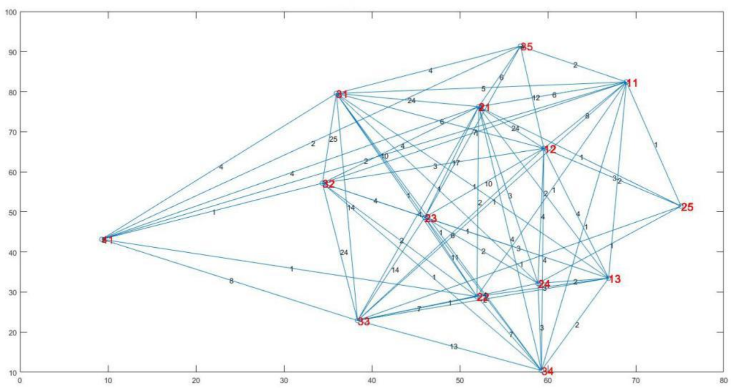


Figure 6: Dynamic Compactness Network of the Huskies

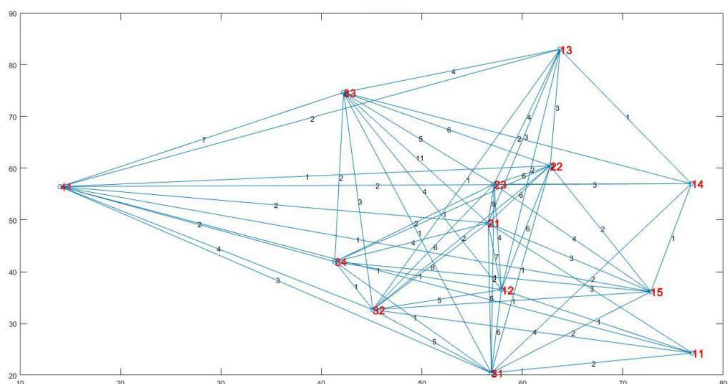


Figure 7: Dynamic Compactness Network of the opponent 1

The players are replaced and the tightness between them remains. For the sake of programming, we still think they are on the field, but the position is no longer changed, so the situation in the picture above exceeds 11 players.

3.5.2 Network Pattern Recognition

In the picture above, the Dynamic Compactness Network is still complex, and we have further processed the relationship network. First of all, we removed the irrelevant players on the field according to the situation of on-court replacement, and then set a threshold value to highlight the players with higher passing compactness. The two Dynamic Compactness Network shown in the **Figure 8,9** are obtained.

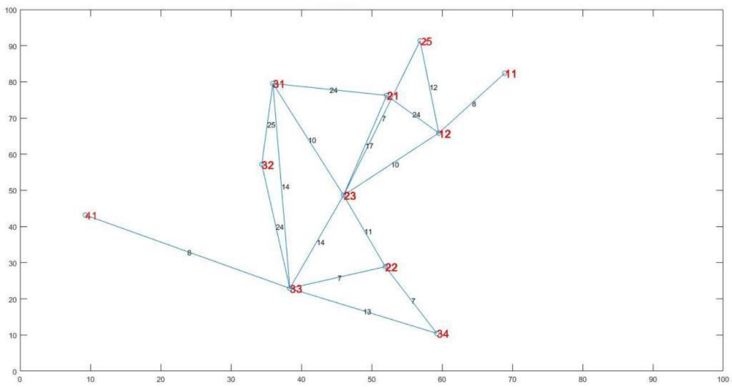


Figure 8: Dynamic Compactness Network of the Huskies

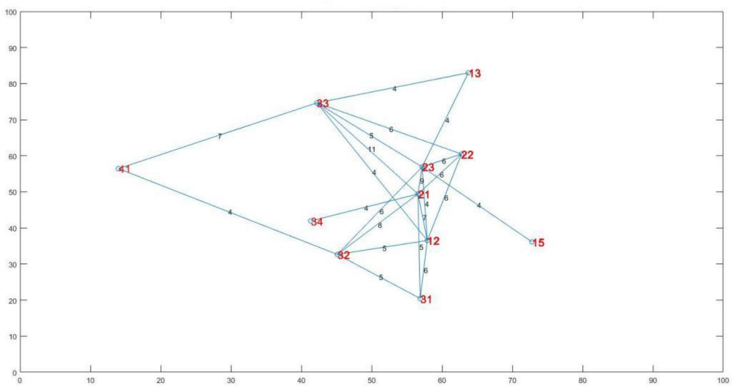


Figure 9: Dynamic Compactness Network of the opponent 1

According to the above figure, we can infer the network pattern by the direction and weight of the arc. We use these two networks as examples to explain the identification of network patterns in detail. Comparing the situation we have obtained throughout the season, the two pictures above are typical of the Eskimo game. At the beginning, the Eskimos chose the 4-3-3 lineup. However, when the Eskimos gained an advantage, the coach chose the 4-4-2 lineup to improve the overall defense of the team. This situation has become the main tone of the Eskimo team this season, but the blind pursuit of defense will be counterproductive.

As can be seen from the figure, Huskies takes Huskies_M3 player as the core, and football transfer is mainly done by him. In addition, Huskies_D1, Huskies_M1, and Huskies_F2 form triadic configurations when the attack is launched, and the offense is quickly launched from the side. After that, it is passed back to the player who has been swept from the middle to complete the goal. Because Huskies has a longer defender line, it advances from the backcourt organization when attacking. Triadic configurations and team formations composed of Huskies_D1, Huskies_D2, and Huskies_D3 promote the attack from the backcourt organization. But in the player ability model, Huskies_D3's Passing Ability is questioned. Therefore, we can think that Huskies_D3 is of low value in the process of controlling the ball, and it should appropriately reduce his importance in the team structure at this time.

3.6 Model Evaluation And Sensitivity Analysis

In order to test the sensitivity of the model, we need to consider the subjective effects of certain coefficients in the P-C Model. In this model, the two main subjective coefficients are λ_{pass} and $k_{distance}$.In the actual model, their values are shown in the **Table 2**.

Table 2: values of main subjective coefficients

Subjective coefficient	Input Data
λ_{pass}	5400
$k_{distance}$	141

In order to ensure that the variables are unique, we randomly extract the Passes Index and the Pass Distance Index between the two members, and then change the value of the coefficient and visualize the result.

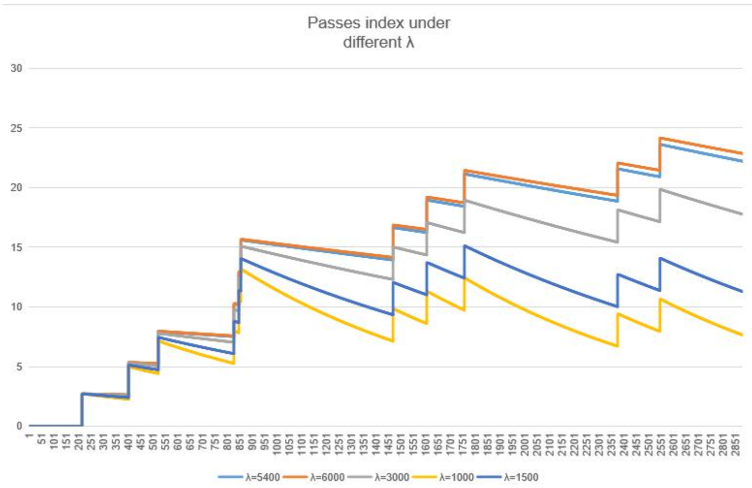


Figure 10: Passes Index under different k

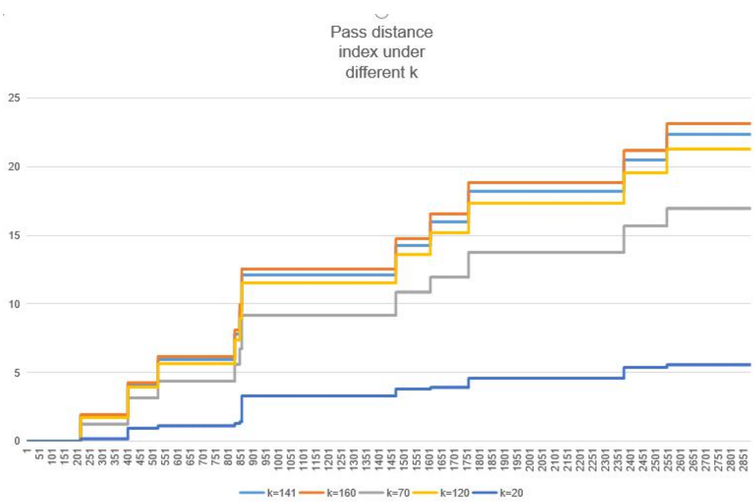


Figure 11: Pass Distance Index under different λ

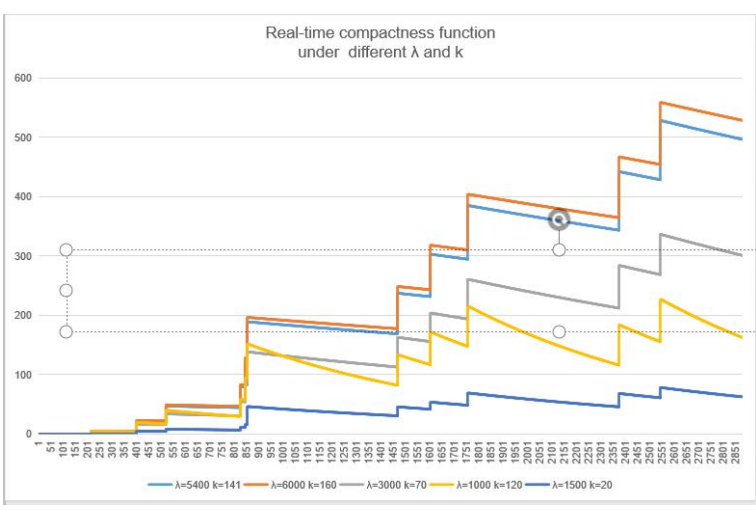


Figure 12: Real-time Compactness Function under different λ and k

From **Figure 10** and **Figure 11**, it can be seen that the influence of λ_{pass} on Passes index and $k_{distance}$ on Pass distance index have both the same points and different points. λ_{pass} and Passes index are negatively correlated, but the degree of negative correlation gradually decreases with the increase of λ_{pass}. When a is greater than 141, the increase has almost no effect on the Passes index. In addition, with the increase of λ_{pass}, the Passes Index's decay over time characteristics are no longer as obvious as before. but due to the continuous superimposition of the number of pass factors, the attenuation of this decay characteristic has basically disappeared. The relationship between $k_{distance}$ and Pass distance index is basically the same as the previous two. When λ_{pass} is greater than 5400, increasing a has almost no effect on the Passes index. Since the Pass Distance Index does not decay over time, $k_{distance}$ has no effect on the Pass Distance Index at this point.

In **Figure 12**, the real-time compactness function is positively related to the sizes of λ_{pass} and $k_{distance}$, but the positive correlation disappears when a exceeds 5400 and $k_{distance}$ exceeds 141. And as the ratio of λ_{pass} and $k_{distance}$ increases, the attenuation characteristics of the real-time compactness function over time become more obvious; as the increasing trend of the ratio of λ_{pass} and $k_{distance}$ decreases, the real-time compactness function becomes more stable with time.

In the actual close relationship, we believe that the Passes Index and Pass Distance Index have basically the same impact on the passing relationship between teammates. At the same time, we hope that the change of the Real-time Compactness Function is sufficiently obvious, so we can consider the current value to be appropriate.

4 AODC Model

We have established a model to evaluate the quality of a team's teamwork from different aspects, called The AODC Model. The AODC model specifically defines four types of performance indicators that reflect teamwork: Adaptability, Offensive, Defensive, and Coordination. We have chosen a limited number of representative factors in accordance with **Pareto's Law** from many factors, and do not measure these indicators after normalization. By judging these indicators to reflect the structure, configuration and dynamic aspects of a team, at the same time, the impact of the team's response to changes in the enemy's strategy can be judged according to the Adaptability. The main strategic intentions of the two teams are to judge the relationship between strategy and counter-strategy.

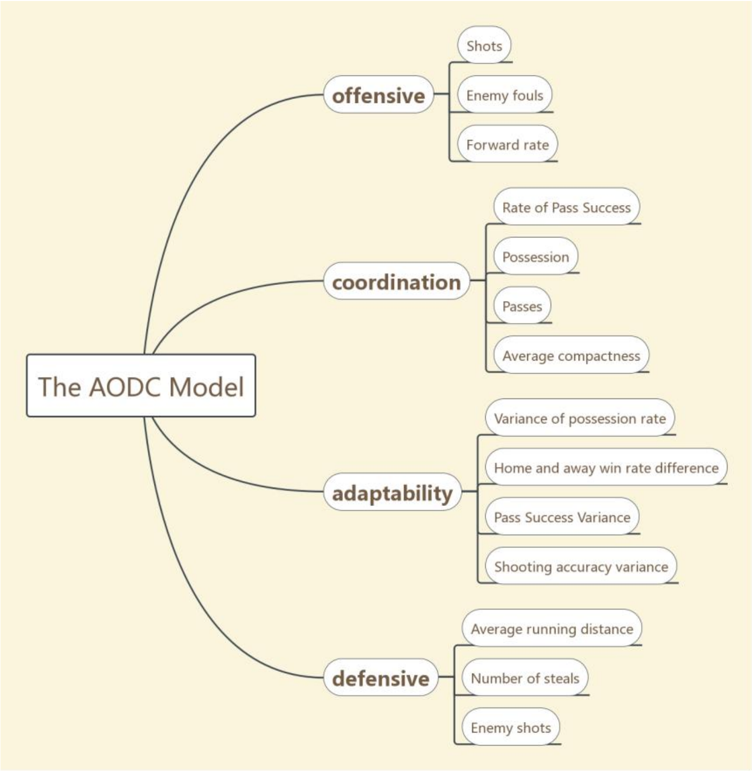


Figure 13: The Relationship Between The Four Indicators and Factors.

Table 3: Notation

Symbol	Description	Symbol	Description
Var_1	Variance of Possession Rate	$foul$	Number of enemy fouls
Var_2	Pass Success Variance	$shot_{otherteam}$	Number of enemy goals
Var_3	Shooting Accuracy Variance	$Others\_on$	Number of others on the ball
Win_rate_{home}	Home win rate	$Rate_{hold}$	Possession
Win_rate_{away}	Away win rate	$Rate_{pass}$	Rate of Pass Success
$shot_{ourteam}$	Number of Our team's goals	$Adap$	The scores of Adaptability
$pass$	Number of passes by our team	$Offe$	The scores of Offensive
$duel$	Number of duels by our team	$Defe$	The scores of Defensive

4.1 Coordination

Coordination is an indicator of the compactness of the links between team members in teamwork. We extracted 4 factors from the game data to measure this indicator.

- **Rate of Pass Success:** Passing can improve the compactness between players and strengthen the connection between the two,while the success rate reflects the ability to cooperate
- .• **Possession**:Possession is the ratio of the time that the team controls the ball to the total time of the game. It can well reflect the scale of a team using the ball to contact. Greater Possession means better collaborative communication and greater control of the game.

- **Passes**:it is the number of all passes made by a team during a match. More passes means that the more complex the passing network between players, the more connections there will be between players. This parameter can largely reflect the communication within the team.
- **Average Compactness**:Average Compactness is a special parameter generated by our definition-the average value of compactness is taken into consideration, taking into account the length of the pass, the number of passes, the distance passed, and the number of passes corresponding to the number of passes between two players Factors such as the number of ball passes by players have a non-negligible impact on the Coordination indicator.

$\alpha_1, \alpha_2, \alpha_3, \alpha_4$ represent weights.The mathematical expression for the effect of four data on indicators in Coordination has a form of

$$Coor = \alpha_1 \times Co_1 + \alpha_2 \times Co_2 + \alpha_3 \times Co_3 + \alpha_4 \times Co_4$$

4.2 Adaptability

Adaptability refers to the team's ability to adapt to a variety of different situations, which reflects the stability of the team when the team is in different situations or facing different opponents. Teams that can play stably can get high evaluation in this indicator. There are four main factors to reflect this indicator.

- **Variance of Possession Rate**: it is the variance of the possession rate in multiple games. It reflects the fluctuation of the team's ability to compete for stadium resources as the opponent changes. We hope that this fluctuation will be small in order to play stably.
- **Home and Away Win Rate Difference**: According to the difference between home and away win rates, we take this difference into the model to reflect the impact of the objective conditions of home and away on the team.
- **Pass Success Variance**: it reflects the fluctuation of the pass success rate in multiple games, which reflects the stability of the team's cooperation status.
- **Shooting Accuracy Variance**: it reflects the stability of the team's Offensive ability.

$\chi_1, \chi_2, \chi_3, \chi_4$ represent weights.The mathematical expression for the effect of four data on indicators in Coordination has a form of

$$Adap = \chi_1 \times Ad_1 + \chi_2 \times Ad_2 + \chi_3 \times Ad_3 + \chi_4 \times Ad_4$$

4.3 Offensive

The performance indicator Offensive reflects the overall pressure of a team in the game and the ability to launch an offense. We use three main factors to reflect this indicator.

- **Shots**: it is the sum of all shots in a game, with or without goals. The number of shots per round is the most intuitive data that reflects the threat of a team. In a football game, an increase in the number of shots per round often leads to an increase in scores, which leads to victory.
- **Enemy Fouls**:Enemy fouls are the number of fouls caused by an enemy team in a game. To some extent, it can reflect the opponent's response to the pressure generated by his team.• Shooting accuracy variance: it reflects the stability of the team's Offensive ability.
- **Forward Rate**:it is the percentage of forward games in a game. The larger this value, the more enthusiastic the team is in attacking, and the longer the opponent is forced to be in Defensive position.

$\beta_1, \beta_2, \beta_3$ represent weights.The mathematical expression for the effect of four data on indicators in Coordination has a form of

$$Offe = \beta_1 \times Of_1 + \beta_2 \times Of_2 + \beta_3 \times Of_3$$

4.4 Defensive

The performance indicator Defensive reflects the team's ability to defend against enemy attacks. We define it with three main factors.

•**Average Running Distance**: it is the average of the total running distance of all the players on the court during the game. The larger the total distance, the more active the player is, and the wider the area that the player can interfere with.
•**Number of Steals**:it is a classic data in football data analysis, which can intuitively reflect the strength of team defense.
•**Enemy Shots**:it can be used to evaluate the overall effectiveness of the team's defense. The smaller the number of shots, the better the defense.

$\delta_1,\delta_2,\delta_3$ represent weights.The mathematical expression for the effect of four data on indicators in Coordination has a form of

$$Defe = \delta_1 \times De_1 + \delta_2 \times De_2 + \delta_3 \times De_3$$

4.5 Normalized Calculation of Factors

The factors of each performance indicator in The AODC model can clearly reflect the characteristics of each performance indicator. However, the dimensions of each different factor are different, and the data are quite different. Therefore, the model normalizes all data for each different factor to the characteristics of the respective data in order to integrate the various factors.

The factors of Adaptability: The variance of the passing success rate and the possession rate variance are reflected in the discreteness of all matches; the changes in the home and away win rate data reflect the impact of objective events. Here we are more concerned about the difference in win rate. The fluctuation of the variance is more severe; the calculation formulas (), (), (), and () are defined by the characteristics of each data.

$$Ad_1 = \frac{\mathrm{Var}_1 - 0.001}{0.015 - 0.001} \qquad Ad_2 = (1 - |Win\_rate_{\mathrm{hom}e} - Win\_rate_{away}|)^{\mathrm{k}}$$

$$Ad_3 = \frac{0.004 - Var_2}{0.004 - 0.002} \qquad Ad_4 = \frac{\mathrm{Var}_3 - 0.025}{0.05 - 0.025}$$

The factors of Offensiveness: the two data of the number of shots and fouls per game are intuitive; pushing this data forward is the result of a contest between the two sides, we are more concerned about the part that exceeds the average; Features define calculation formulas ,respectively.

$$Of_1 = 1 - 3 \times e^{-(Shot_{ourteam}+5)/5} \qquad Of_2 = 1 - e^{-foul/10} \qquad Of_3 = 0.5 + \left(\frac{\frac{duel}{pass} - 0.5}{0.5}\right)^i$$

The factors of Defensive: The evaluation of the average overall run refers to the full-field run, which can give a staged score conversion standard; The other three figures intuitively reflect the team's defensive capabilities. The calculation formulas are defined by the characteristics of each data.

$$De_1 = \frac{Other\_on}{100} \qquad De_2 = 2 \times e^{-Shot_{otherteam}/10}$$

the factors of Coordination: the ball control rate reflects the game process between the two sides, we pay more attention to the gap with the median; the number of passes passes a given metric, and the linear value method can be used; compactness data requires periodic evaluation. The calculation formulas are defined by the characteristics of each data.

$$Co_1 = Rate_{hold} + 0.1 \qquad Co_2 = Rate_{pass} \qquad Co_3 = \frac{Pass - 200}{500 - 200} \times 100\%$$

The normalized results of each factor of the Huskies team are calculated from the above calculation formulas and listed in **Table 4:**

Table 4: Normalized Result

Influencing factors	Normalized Result
Variance of Possession Rate	0.6
Home and Away Win Rate Difference	0.398
Pass Success Variance	0.81
Shooting Accuracy Variance	0.6
Shots	0.74
Enemy Fouls	0.629
Forward Rate	0.64
Average Running Distance	0.76
Number of Steals	0.668
Enemy Shots	0.619
Possession	0.5364
Rate of Pass Success	0.8414
Passes	0.56
Average Compactness	0.6

4.6 Weight Calculation

We construct a judgment matrix for the influencing factors of each performance indicator, and use the analytic hierarchy process to calculate the weight value of each factor on the performance indicator to which it belongs. The calculated weight values are listed in the **Table 5.**

Table 5: Weight

Influencing factors	Weights
Variance of Possession Rate	0.2863
Home and Away Win Rate Difference	0.4348
Pass Success Variance	0.0969
Shooting Accuracy Variance	0.182
Shots	0.5714
Enemy Fouls	0.1429
Forward Rate	0.2857
Average Running Distance	0.5
Number of Steals	0.25
Enemy Shots	0.25

Then we have the following complete calculation formula:

$$Adap = (28.63\%)\ Ad_1 + (43.48\%)\ Ad_2 + (9.69\%)\ Ad_3 + (18.2\%)\ Ad_4$$
$$Offe = (57.14\%)\ Of_1 + (14.29\%)\ Of_2 + (28.57\%)\ Of_3$$
$$Defe = (25\%)\ De_1 + (25\%)\ De_2 + (50\%)\ De_3$$
$$Coor = (11.86\%)\ Co_1 + (3.09\%)\ Co_2 + (41.42\%)\ Co_3 + (15.81\%)\ Co_4$$

Substituting the normalized score data into the above formula, the average score obtained is a number between zero and one. A higher score indicates that the team is stronger in this regard. The average score of each performance indicator of the Huskies' 38 games is shown in the **Figure 14**.

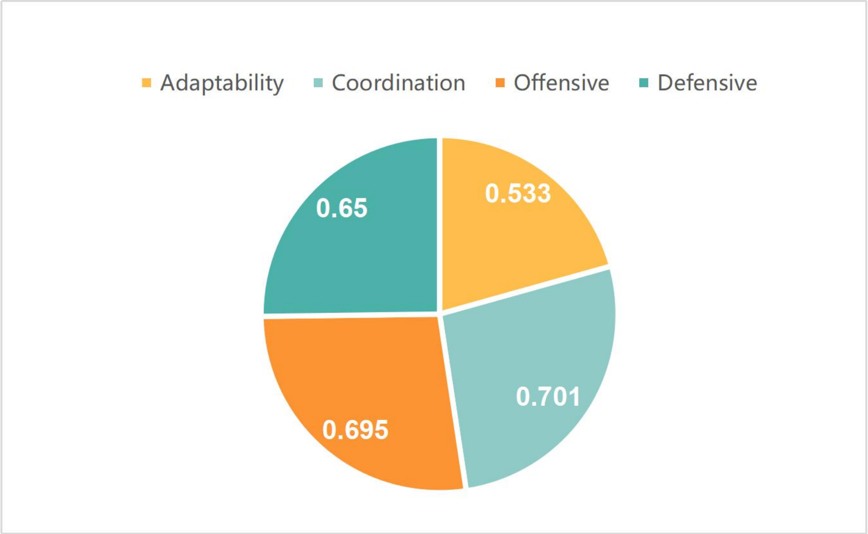


Figure 14: The relationship between the four indicators and factors.

As can be seen from the figure, the Huskies team is a team with both offense and defense, but because of overemphasizing this point, the Huskies is not so prominent in both aspects. In terms of Coordination, the Huskies is also obviously very mediocre, with fewer passing balls and mostly relying on opponents' mistakes to score.

4.7 Simulation

We select data from the authoritative football website, use this model to analyze, give the standard value of the team cooperation index we set, and compare it with the team cooperation attribute of the analyzed team. The parameters shown reflect the teamwork attributes of the team to some extent. We have selected Norwich Club, Bayern Munich Club, Juventus in 29 games in 2019 [5] for analysis. The analysis results are shown in Table 6 and Table 7:

Table 6: Weights

Influencing factors	Norwich	Bayern Munich	Juventus
Variance of Possession Rate	0.65	0.2863	0.74
Home and Away Win Rate Difference	0.71	0.4348	0.95
Pass Success Variance	0.65	0.0969	0.85
Shooting Accuracy Variance	0.67	0.182	0.80
Shots	0.79	0.5714	0.85
Enemy Fouls	0.72	0.1429	0.73
Forward Rate	0.69	0.2857	0.70
Average Running Distance	0.65	0.5	0.73
Number of Steals	0.71	0.25	0.85
Enemy Shots	0.632	0.25	0.871
Possession	0.712	0.2863	0.742
Rate of Pass Success	0.71	0.4348	0.874
Passes	0.61	0.0969	0.81
Average Compactness	0.652	0.182	0.801

Table 7: Performance indicator average score for four clubs

	Adaptability	Coordination	Offensive	Defensive
Bayern Munich	0.8835298	0.825613	0.858563	0.69925
Juventus	0.82	0.830	0.790	0.853
Norwich	0.66	0.68	0.75	0.66
Huskies	0.533	0.695	0.701	0.65

Compared with the other three teams, the Huskies is a team with a lower middle score, and its four performance indicators are significantly weaker than other teams.At the same time, the attributes represented by these four performance indicators are very close to the style of the other three teams.The Bayern Munich focuses on offense and coordination, and the defense is weak, while the Juventus is more comprehensive offensive and defensive, unlike the previous two Norwich's record is closer to the Huskies, so we can consider these four performance indicators to be more accurate.

The Huskies team has been analyzed before, and here we will focus on evaluating his low Adaptability. The low Adaptability shows that the Huskies team has no way to restrain the change of opponent's strategy and strategy, and the coach's tactics lack flexibility. At the same time, when the Huskies is more defensive at certain moments, that is, when the Husky team's formation is more mainly for defense, teams with higher Coordination can often limit the Huskies team well. We therefore propose that effectiveness of the strategy is related to the anti-strategy to a certain extent.

5 Build An Effective Team

Competitive team sports is a typical teamwork activity. In the two models that have been established the P-C Model and the AODC Model, we explore the internal connection of football team cooperation and how it affects the performance of team cooperation, and gives the a way to evaluate teamwork. Based on these two models, we can build a judgment basis for an effective team

Based on the P-C Model and the AODC Model, we consider the four levels of the team structure: the individual level, the level between members, the level of the overall members, and the level of the team. And at these six levels, the six indicators shown in **Figure 15** below are proposed.

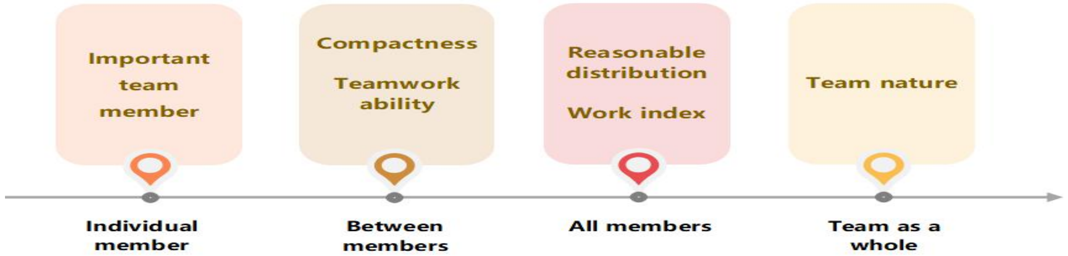


Figure 15: Schematic diagram of a good teamwork model

The directed network diagram established by the P-C Model intuitively shows the compactness and integration of internal connections among team members.the P-C Model is applied to a wide range of teamwork in society. Compactness is the efficiency of resource transfer and integration within the team. It affects the effectiveness of teamwork at the level of members.Through the relationship network in the P-C Model, we can know the members who are important in cooperation, and evaluate whether these members are valuable for teamwork by evaluating the value of these members.The directed network embodied in the P-C Model can be equivalent to the flow of resources and information within the team.Through the analysis of these data, we can draw the impact of the reasonable allocation of resources on teamwork, which affects the effectiveness of teamwork at the level of all members.

In the above, the AODC model intuitively reflects the nature of the team through the basic data.Therefore, we can use the data provided by other models to capture the transmission and communication of team resources and information, important member information, the team's recent performance, member work indicators and other information to quantify six indicators of high-quality team cooperation models.

6 Strengths And Weaknesses

6.1 Strengths

•The factors considered in the AODC model are relatively comprehensive, and the model is not prone to misjudgment due to lack of consideration.

•The Compactness Formula reflects the influence of time and distance on the relationship between the two. At the same time, using the integral method can reflect the main closeness relationship in the game, so as to judge the team's strategic tactics.

•Our Dynamic Compactness Network can display the distribution of players on the court and their connections in real time, which can well judge the current situation of the stadium.

•We introduce a player capability model, which is helpful for judging an individual's overall value. The coach can adjust the tactical status of players with low value based on this model and the dynamic close relationship network.

6.2 Weaknesses

•The two main models have a large demand for data and a large amount of data processing, so they are not suitable for situations where the amount of data is small.

•Due to the amount of data, our compactness function uses fewer indicators. In the actual stadium, more indicators should be used to complete the analysis.

7 Conclusion：A Letter Of Advice to The Management of The Huskies

Dear Sir/Madam,
my company, Intrepid Champion Modeling (ICM), is invited to lend a helping hand to you to understand the team's dynamics, explore the complex interactions within the team, and seek for cooperative strategies that enhance the overall strength of the team.
First and foremost, we reckon that your team's overall Compactness is poor, and the team's strategic tactics are relatively conservative compared to other teams, so we recommend that your team ought to be more determined to implement some tactics and open the opponent's defense by transmitting the ball .

Secondly, the overall strength of the Huskies is average,which is the result of the coach's emphasis on Offensive and Defensive balance, but the blind pursuit of defense after the Offensive lead will not have much positive impact on the team. We reckon that the coach are supposed to be aware of the situation on the court and understand the timing of attack or defense so as to strike a balance between offense and defense.

Apart from this, we found some low-value players through the network model we built.Given that the team has the ability, you might as well consider buying some backcourt players who are stable in ball control, excellent at assists and conduction. Coaches can also adjust strategies and tactics for these lower value members.

What’s more,we think that the Huskies' Adaptability is poor, on account that the team members are unstable, affected by away games, and the coach's ability to respond to opponents' strategy changes is not strong.

Last but not least, We wrote an extremely complicated program to get the offensive heat map of the Huskies team this season. The yellow area represents the average offensive area of our players throughout the season. Since this area is close to the boundary, we may safely draw a conclusion that their main offensive method is the wing attack, pulling the opponent's defense line by the length of the court, which is consistent with the results of the P-C model analysis.And the positions of the players are scattered during the offense, which indicates that the coach is afraid of attacking when deploying tactics and is worried about the opponent's defensive attack. But in fact this strategy has greatly reduced the overall competitiveness of the Huskies.

Sincere appreciation for taking the time to read our manuscript. I hope our suggestions will be helpful to you. I’m looking forward to your success in the new season!

Sincerely

members of team#2010905

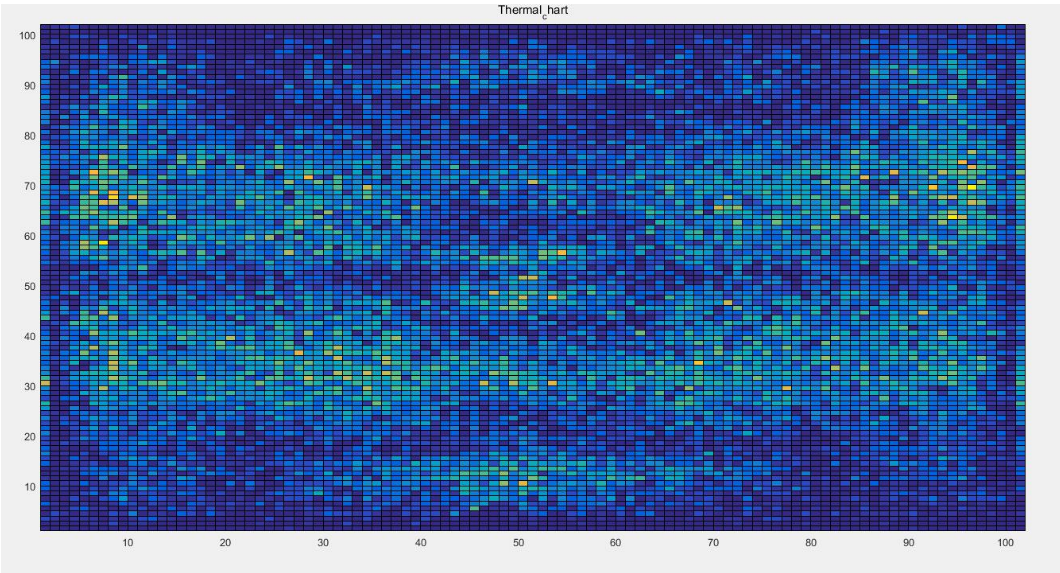


Figure 16: Offensive heat map throughout the season

References

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[2] Duch J., Waitzman J.S., Amaral L.A.N. (2010). Quantifying the performance of individual

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[3]Buldú, J.M., Busquets, J., Echegoyen, I. et al. (2019). Defining a historic football team: Using Network Science to analyze Guardiola's F.C. Barcelona. Sci Rep, 9, 13602.

[4] Thomas U. Grund,Network structure and team performance: The case of English Premier League soccer teams,Social Networks,Volume 34, Issue 4, October 2012, Pages 682-690

[5] https://www.whoscored.com/Teams/37/Fixtures/Germany-Bayern-Munich

Appendices matlab code

```
clc,clear;
%Macro definition
position_x = 1;                %col 1 x coordinate  array
position_y = 2;                %col 2 y coordinate  array
v_x = 3;                       %col 3 x Coordinate change array
v_y = 4;                       %col 4 y Coordinate change array?
name = 5;                      %col 5 Grade
e_time = 6;                    %col 6 Event update time
player_event_num = 7;          %col 7 Event sum
player_event_count = 8;        %col 8 Record variables
player_game_state = 9;         %col 9 state of athletes
player_time = 10;              %State change time
xiachang  = 11;
%% Init data
[number,txt,raw] = xlsread('C:/Users/Administrator/Desktop/bisai/2020_Problem_D_DATA/passingevents.csv');
[number_1,txt_1,raw_1] = xlsread('C:/Users/Administrator/Desktop/bisai/2020_Problem_D_DATA/fullevents.csv');
[hang,lie] = size(txt);
[hang_1,lie_1] = size(txt_1);
field_num = 1:1:38;
Huskies_pass_num = zeros(1,38);                  %Huskies Pass number matrix
Opponent_pass_num = zeros(1,38);                 %Opponent Pass number matrix
Huskies_team_state = cell(40,30);                %Huskies team state matrix row game_number col team_name
Opponent_team_state = cell(40,30);               %Opponent team state matrix row game_number col team_name
Huskies_team_num = zeros(1,38);                  %Huskies team number matrix col game_number
Opponent_team_num = zeros(1,38);                 %Opponent team number matrix col game_number
Huskies_count_one = 0;                           %Huskies OriginPlayerID Record variables
Huskies_count_two = 0;                           %Huskies DestinationPlayerID Record variables
Opponent_count_one = 0;                          %Opponent OriginPlayerID Record variables
Opponent_count_two = 0;                          %Opponent DestinationPlayerID Record variables
Match_1H_count = zeros(1,38);                    %First half of game time col game_number
Match_2H_count = zeros(1,38);                    %Second half of game time col game_number
unit_1H_time = zeros(1,38);                      %First half of game Unit conversion col game_number
unit_2H_time = zeros(1,38);                      %Second half of game Unit conversion col game_number
%% Find out how many teams record their names and their names
[team_storage,team_num] = species_count(2,2,hang,txt);
%% Query event home directory type
[event_type,event_type_num] = species_count(7,2,hang_1,txt_1);
%% Query event subdirectory type
```

```
[sub_event_type,sub_type_num] = sub_species_count(7,event_type_num,8,2,hang_1,txt_1,event_type);
%% Record the number of passes per game
sum_pass_num = numder_species_sum(1 , 1 , (hang-1) , number , field_num , 38);
%% Number of recorded events
sum_event = numder_species_sum(1 , 1 , (hang_1-1) , number_1 , field_num , 38);
%% Count the total passes of Huskies and opponent
j = 1;
for i = 1:38
    Huskies_pass_num(1,i) = species_sum(2,j+1,j+sum_pass_num(1,i),txt,team_storage{1,1});
    Opponent_pass_num(1,i) = sum_pass_num(1,i) - Huskies_pass_num(1,i);
    j = j + sum_pass_num(1,i);
end
%% Record the time of changing field
j = 0;
for i = 1:38
    Match_1H_count(1,i) = species_sum(5,j+1,j+sum_event(1,i),txt_1,'1H');
    Match_2H_count(1,i) = sum_event(1,i);
    unit_1H_time(1,i) = number_1(Match_1H_count(1,i)+j,6)/3600;   %Conversion to seconds
    unit_2H_time(1,i) = number_1(Match_2H_count(1,i)+j,6)/3600;
    j = j + sum_event(1,i);
end
%% Count player name information
j = 1;
for i = 1:38
    [Huskies_team_state(i,:),Huskies_team_num(1,i),Opponent_team_state(i,:),Opponent_team_num(1,i)] = ...
        player_species_count(3,j+1,j+sum_event(1,i),txt_1,team_storage{1,1});
    j = j + sum_event(1,i);
end
%% Member information cell initialization
Huskies_pixel_info = cell(1,38);
Opponent_pixel_info = cell(1,38);
for count = 1:38
    Huskies_pixel_info{1,count} = cell(Huskies_team_num(1,count),10);
    Opponent_pixel_info{1,count} = cell(Huskies_team_num(1,count),10);
end

for count = 1:38
    for i = 1:Huskies_team_num(1,count)
        Huskies_pixel_info{1,count}{i,player_game_state} = 0;
    end
end
%% Event recorder initialization
for count = 1:38
    for i = 1:Huskies_team_num(1,count)
        Huskies_pixel_info{1,count}{i,8} = 1;
        Huskies_pixel_info{1,count}{i,9} = 0;
    end
    for i = 1:Opponent_team_num(1,count)
        Opponent_pixel_info{1,count}{i,8} = 1;
        Opponent_pixel_info{1,count}{i,9} = 0;
    end
end
```

```
%% Label team members
for count = 1:38
    for i = 1:Huskies_team_num(1,count)
        Huskies_pixel_info{1,count}{i,name} = player_str_to_number(Huskies_team_state{count,i});
    end
    for i = 1:Opponent_team_num(1,count)
        Opponent_pixel_info{1,count}{i,name} = player_str_to_number(Opponent_team_state{count,i});
    end
end
        %% Bubble sort
        for count = 1:38
            for i = 2 : Huskies_team_num(1,count)-1
                for j = Huskies_team_num(1,count) : -1 : i
                    if Huskies_pixel_info{1,count}{j,name} <  Huskies_pixel_info{1,count}{j-1,name}
                        num = Huskies_pixel_info{1,count}{j,name};
                        Huskies_pixel_info{1,count}{j,name} = Huskies_pixel_info{1,count}{j-1,name};
                        Huskies_pixel_info{1,count}{j-1,name} = num;
                    end
                end
            end

            for i = 2 : Opponent_team_num(1,count)-1
                for j = Opponent_team_num(1,count) : -1 : i
                    if Opponent_pixel_info{1,count}{j,name} <  Opponent_pixel_info{1,count}{j-1,name}
                        num = Opponent_pixel_info{1,count}{j,name};
                        Opponent_pixel_info{1,count}{j,name} = Opponent_pixel_info{1,count}{j-1,name};
                        Opponent_pixel_info{1,count}{j-1,name} = num;
                    end
                end
            end
        end
        %% Record team coordinate information
        j=1;
        char_value = 0;
        i = 0;
        flag = 0;
        for count = 1:38
            for num = 1:sum_event(1,count)
                if ~strcmp(txt_1{num+j,7},'Substitution')
                    char_value = player_str_to_number(txt_1{num+j,3});
                    [i , flag] = search_player(txt_1{num+j,3},char_value,Huskies_pixel_info{1,count},Huskies_team_num(1,count),Opponent_pixel_info{1,count},Opponent_team_num(1,count));
                    if flag == 2
                        Huskies_pixel_info{1,count}{i,position_x} = [Huskies_pixel_info{1,count}{i,position_x},number_1(num-1+j,9)];                   %Huskies Pass player x position
                        Huskies_pixel_info{1,count}{i,position_y} = [Huskies_pixel_info{1,count}{i,position_y},number_1(num-1+j,10)];                  %Huskies Pass player y position
                        Huskies_pixel_info{1,count}{i,e_time} = [Huskies_pixel_info{1,count}{i,e_time},number_1(num-1+j,6)];                           %Huskies Pass time
```

```
                Huskies_pixel_info{1,count}{i,player_time} = [Huskies_pixel_info{1,count}{i,player_time},txt_1{num+j,5}];
                if ((Huskies_pixel_info{1,count}{i,player_game_state} ~= 3)&&(Huskies_pixel_info{1,count}{i,player_game_state} ~= 2))
                    Huskies_pixel_info{1,count}{i,player_game_state} = 1;
                end
            else
                Opponent_pixel_info{1,count}{i,position_x} = [Opponent_pixel_info{1,count}{i,position_x},(100-number_1(num-1+j,9))];    %Opponent Pass player x position
                Opponent_pixel_info{1,count}{i,position_y} = [Opponent_pixel_info{1,count}{i,position_y},(100-number_1(num-1+j,10))];   %Opponent Pass player y position
                Opponent_pixel_info{1,count}{i,e_time} = [Opponent_pixel_info{1,count}{i,e_time},number_1(num-1+j,6)];                  %Opponent Pass time
                Opponent_pixel_info{1,count}{i,player_time} = [Opponent_pixel_info{1,count}{i,player_time},txt_1{num+j,5}];
                if ((Opponent_pixel_info{1,count}{i,player_game_state} ~= 3)&&(Opponent_pixel_info{1,count}{i,player_game_state} ~= 2))
                    Opponent_pixel_info{1,count}{i,player_game_state} = 1;

                end
            end
            if ~isempty(txt_1{num+j,4})
               char_value = player_str_to_number(txt_1{num+j,4});
               [i , flag] = search_player(txt_1{num+j,4},char_value,Huskies_pixel_info{1,count},Huskies_team_num(1,count),Opponent_pixel_info{1,count},Opponent_team_num(1,count));
               if flag == 2
                    Huskies_pixel_info{1,count}{i,position_x} = [Huskies_pixel_info{1,count}{i,position_x},number_1(num-1+j,11)];
                    Huskies_pixel_info{1,count}{i,position_y} = [Huskies_pixel_info{1,count}{i,position_y},number_1(num-1+j,12)];
                    Huskies_pixel_info{1,count}{i,e_time} = [Huskies_pixel_info{1,count}{i,e_time},number_1(num-1+j,6)];
                    Huskies_pixel_info{1,count}{i,player_time} = [Huskies_pixel_info{1,count}{i,player_time},txt_1{num+j,5}];
                    if ((Huskies_pixel_info{1,count}{i,player_game_state} ~= 3)&&(Huskies_pixel_info{1,count}{i,player_game_state} ~= 2))
                        Huskies_pixel_info{1,count}{i,player_game_state} = 1;

                    end
               else
                    Opponent_pixel_info{1,count}{i,position_x} = [Opponent_pixel_info{1,count}{i,position_x},(100-number_1(num-1+j,11))];
                    Opponent_pixel_info{1,count}{i,position_y} = [Opponent_pixel_info{1,count}{i,position_y},(100-number_1(num-1+j,12))];
                    Opponent_pixel_info{1,count}{i,e_time} = [Opponent_pixel_info{1,count}{i,e_time},number_1(num-1+j,6)];
                    Opponent_pixel_info{1,count}{i,player_time} = [Opponent_pixel_info{1,count}{i,player_time},txt_1{num+j,5}];
                    if ((Opponent_pixel_info{1,count}{i,player_game_state} ~= 3)&&(Opponent_pixel_info{1,count}{i,player_game_state} ~= 2))
                        Opponent_pixel_info{1,count}{i,player_game_state} = 1;

                    end
                end
            end
        else
            char_value = player_str_to_number(txt_1{num+j,3});
```

```
                [i , flag] = search_player(txt_1{num+j,3},char_value,Huskies_pixel_info{1,count},Huskies_team_num(1,count),Opponent_pixel_info{1,count},Opponent_team_num(1,count));
                if flag == 2
                    Huskies_pixel_info{1,count}{i,player_game_state} = 2;          %substitution
                    Huskies_pixel_info{1,count}{i,e_time} = [Huskies_pixel_info{1,count}{i,e_time},number_1(num-1+j,6)];        %substitution time
                    Huskies_pixel_info{1,count}{i,player_time} = [Huskies_pixel_info{1,count}{i,player_time},txt_1{num+j,5}];
                else
                    Opponent_pixel_info{1,count}{i,player_game_state} = 2;
                    Opponent_pixel_info{1,count}{i,e_time} = [Opponent_pixel_info{1,count}{i,e_time},number_1(num-1+j,6)];
                    Opponent_pixel_info{1,count}{i,player_time} = [Opponent_pixel_info{1,count}{i,player_time},txt_1{num+j,5}];
                end
                if ~isempty(txt_1{num+j,4})
                    char_value = player_str_to_number(txt_1{num+j,4});
                    [i , flag] = search_player(txt_1{num+j,4},char_value,Huskies_pixel_info{1,count},Huskies_team_num(1,count),Opponent_pixel_info{1,count},Opponent_team_num(1,count));
                    if flag == 2
                        Huskies_pixel_info{1,count}{i,player_game_state} = 3;
                        Huskies_pixel_info{1,count}{i,e_time} = [Huskies_pixel_info{1,count}{i,e_time},number_1(num-1+j,6)];
                        Huskies_pixel_info{1,count}{i,player_time} = [Huskies_pixel_info{1,count}{i,player_time},txt_1{num+j,5}];
                    else
                        Opponent_pixel_info{1,count}{i,player_game_state} = 3;
                        Opponent_pixel_info{1,count}{i,e_time} = [ Opponent_pixel_info{1,count}{i,e_time},number_1(num-1+j,6)];
                        Opponent_pixel_info{1,count}{i,player_time} = [Opponent_pixel_info{1,count}{i,player_time},txt_1{num+j,5}];
                    end
                end
            end
        end
        j = j + sum_event(1,count);
        flag = 1;
    end
    %% Information quantity calculation
    for count = 1:38
        for i = 1:Huskies_team_num(1,count)
            char_value = Huskies_pixel_info{1,count}{i,position_x};
            [x1,x2] = size(char_value);
            Huskies_pixel_info{1,count}{i,player_event_num} = x2;
        end
        for i = 1:Opponent_team_num(1,count)
            char_value = Opponent_pixel_info{1,count}{i,position_x};
            [x1,x2] = size(char_value);
            Opponent_pixel_info{1,count}{i,player_event_num} = x2;
        end
    end
    %% Initialization of player coordinate variable
    Huskies_map_x = cell(1,38);
    Huskies_map_y = cell(1,38);
    Opponent_map_x = cell(1,38);
```

```
    Opponent_map_y = cell(1,38);
    for count = 1:38
        Huskies_map_x{1,count} = zeros(1,Huskies_team_num(1,count));
        Huskies_map_y{1,count}=  zeros(1,Huskies_team_num(1,count));
        Opponent_map_x{1,count} =zeros(1,Opponent_team_num(1,count));
        Opponent_map_y{1,count} = zeros(1,Opponent_team_num(1,count));
    end
    %% Calculation of players' average coordinates
    for count = 1:38
        for i = 1:Huskies_team_num(1,count)
            for j = 1:Huskies_pixel_info{1,count}{i,7}
                Huskies_map_x{1,count}(1,i) = Huskies_map_x{1,count}(1,i) + Huskies_pixel_info{1,count}{i,position_x}(1,j);
                Huskies_map_y{1,count}(1,i) = Huskies_map_y{1,count}(1,i) + Huskies_pixel_info{1,count}{i,position_y}(1,j);
            end
            Huskies_map_x{1,count}(1,i) = Huskies_map_x{1,count}(1,i)/Huskies_pixel_info{1,count}{i,player_event_num};
            Huskies_map_y{1,count}(1,i) = Huskies_map_y{1,count}(1,i)/Huskies_pixel_info{1,count}{i,player_event_num};
        end
        for i = 1:Opponent_team_num(1,count)
            for j = 1:Opponent_pixel_info{1,count}{i,7}
                Opponent_map_x{1,count}(1,i) = Opponent_map_x{1,count}(1,i) + Opponent_pixel_info{1,count}{i,position_x}(1,j);
                Opponent_map_y{1,count}(1,i) = Opponent_map_y{1,count}(1,i) + Opponent_pixel_info{1,count}{i,position_y}(1,j);
            end
            Opponent_map_x{1,count}(1,i) = Opponent_map_x{1,count}(1,i)/Opponent_pixel_info{1,count}{i,player_event_num};
            Opponent_map_y{1,count}(1,i) = Opponent_map_y{1,count}(1,i)/Opponent_pixel_info{1,count}{i,player_event_num};
        end
    end
    %% Search the corresponding adjacency matrix information
    j=1;
    Huskies_team_graph = cell(1,38); %Huskies Graph theory storage variable of game passing col game_number
    Opponent_team_graph = cell(1,38); %Opponent Graph theory storage variable of game passing col game_number
    for count = 1:38
        Huskies_team_graph{1,count} = zeros(Huskies_team_num(1,count),Huskies_team_num(1,count));%Huskies adjacency matrix
        Opponent_team_graph{1,count} = zeros(Opponent_team_num(1,count),Opponent_team_num(1,count));%Opponent adjacency matrix
    end
    for count = 1:38
        for num = 1:sum_pass_num(1,count)
            char_value = player_str_to_number(txt{num+j,3});
            [i , flag] = search_player(txt{num+j,3},char_value,Huskies_pixel_info{1,count},Huskies_team_num(1,count),Opponent_pixel_info{1,count},Opponent_team_num(1,count));
            if flag == 2
                Huskies_count_one = i;                          %Record passers
            else
                Opponent_count_one = i;
            end
            char_value = player_str_to_number(txt{num+j,4});
```

```
                [i , flag] = search_player(txt{num+j,4},char_value,Huskies_pixel_info{1,count},Huskies_team_num(1,count),Opponent_pixel_info{1,count},Opponent_team_num(1,count));
                if flag == 2
                    Huskies_count_two = i ;     %Record passers
                    Huskies_team_graph{1,count}(Huskies_count_one,Huskies_count_two) = Huskies_team_graph{1,count}(Huskies_count_one,Huskies_count_two) + 1;
                    Huskies_team_graph{1,count}(Huskies_count_two,Huskies_count_one) = Huskies_team_graph{1,count}(Huskies_count_two,Huskies_count_one) + 1;
                else
                    Opponent_count_two = i;    %Record Opponent Destination Player ID number
                    Opponent_team_graph{1,count}(Opponent_count_one,Opponent_count_two) = Opponent_team_graph{1,count}(Opponent_count_one,Opponent_count_two) + 1;
                    Opponent_team_graph{1,count}(Opponent_count_two,Opponent_count_one) = Opponent_team_graph{1,count}(Opponent_count_two,Opponent_count_one) + 1;
                end
            end
            j = j + sum_pass_num(1,count);
        end
        %% Initialization of players' passing compactness
        Huskies_Close_num = cell(1,38);
        Opponent_Close_num = cell(1,38);
        Huskies_graph_z = cell(1,38);
        Opponent_graph_z = cell(1,38);
        for count = 1:38
            Huskies_Close_num{1,count} = zeros(Huskies_team_num(1,count),Huskies_team_num(1,count));
            Opponent_Close_num{1,count} = zeros(Opponent_team_num(1,count),Opponent_team_num(1,count));
            Huskies_graph_z{1,count} = zeros(Huskies_team_num(1,count),Huskies_team_num(1,count));
            Opponent_graph_z{1,count}= zeros(Opponent_team_num(1,count),Opponent_team_num(1,count));
        end
        %% Search for the corresponding pass compactness matrix information
        j = 1;
        for count = 1:38
            for num = 1:sum_pass_num(1,count)
                char_value = player_str_to_number(txt{num+j,3});
                [i , flag] = search_player(txt{num+j,3},char_value,Huskies_pixel_info{1,count},Huskies_team_num(1,count),Opponent_pixel_info{1,count},Opponent_team_num(1,count));
                if flag == 2
                    Huskies_count_one = i;                              %Record passers
                else
                    Opponent_count_one = i;                             %Record passers
                end
                char_value = player_str_to_number(txt{num+j,4});
                [i , flag] = search_player(txt{num+j,4},char_value,Huskies_pixel_info{1,count},Huskies_team_num(1,count),Opponent_pixel_info{1,count},Opponent_team_num(1,count));
                if flag == 2
                    Huskies_count_two = i ;
                    if num == 1
                        Huskies_Close_num{1,count} = updata(Huskies_team_num(1,count),Huskies_Close_num{1,count},Huskies_count_one ,Huskies_count_two,0,number(num-
```

```
1+j,6),0.1,10,number(num-1+j,8),number(num-1+j,9),number(num-1+j,10),number(num-1+j,11),120);
                else
                    Huskies_Close_num{1,count} = updata(Huskies_team_num(1,count),Huskies_Close_num{1,count},Huskies_count_one ,Huskies_count_two,number(num-2+j,6),number(num-1+j,6),0.1,10,number(num-1+j,8),number(num-1+j,9),number(num-1+j,10),number(num-1+j,11),120);
                end
                Huskies_graph_z{1,count} = Huskies_graph_z{1,count} + Huskies_Close_num{1,count};
            else
                Opponent_count_two = i;
                if num == 1
                    Opponent_Close_num{1,count} = updata(Opponent_team_num(1,count),Opponent_Close_num{1,count},Opponent_count_one ,Opponent_count_two,0,number(num-1+j,6),0.1,10,number(num-1+j,8),number(num-1+j,9),number(num-1+j,10),number(num-1+j,11),120);
                else
                    Opponent_Close_num{1,count} = updata(Opponent_team_num(1,count),Opponent_Close_num{1,count},Opponent_count_one ,Opponent_count_two,number(num-2+j,6),number(num-1+j,6),0.1,10,number(num-1+j,8),number(num-1+j,9),number(num-1+j,10),number(num-1+j,11),120);
                end
                Opponent_graph_z{1,count} = Opponent_graph_z{1,count} + Opponent_Close_num{1,count};
            end
        end
        j = j + sum_pass_num(1,count);
    end
    %% Ball control rate information
    Huskies_C_R_U = zeros(1,38); %First half possession time
    Huskies_C_R_D = zeros(1,38); %Possession time in the second half
    Huskies_C_R_S = zeros(1,38); %Full court possession time
    Opponent_C_R_U = zeros(1,38);
    Opponent_C_R_D = zeros(1,38);
    Opponent_C_R_S = zeros(1,38);
    Huskies_C_U_rate = zeros(1,38); %First half possession rate
    Huskies_C_D_rate = zeros(1,38); %Possession time in the second half
    Huskies_C_S_rate= zeros(1,38); %Full court possession time
    Opponent_C_U_rate = zeros(1,38);
    Opponent_C_D_rate = zeros(1,38);
    Opponent_C_S_rate = zeros(1,38);
    ball_judge = 3;
    former_ball_judge = 3;
    j = 1;
    event_flag = 0;
    event_ball_number = zeros(1,hang_1);
    event_attack_number = zeros(1,hang_1);
    ball_flag = 0;
    attack_flag = 0;
    Huskies_control_begain = -1;
    Huskies_control_end = 0;
    Opponent_control_begain = -1;
    Opponent_control_end = 0;
    %Generate ball weight array
    for count = 1:38
        for num = 1:sum_event(1,count)
            event_flag= Judge_ball_right(txt_1{num+j,7},txt_1{num+j,8});
```

```
                if (floor(event_flag/10) == 1)||(floor(event_flag/10) == 3)||(floor(event_flag/10) == 9)
                    if strncmpi(txt_1{num+j,2},'Huskies',4)
                        event_attack_number(1,num+j) = 1;
                    else
                        event_attack_number(1,num+j) = 2;
                    end
                else
                    event_attack_number(1,num+j) = event_attack_number(1,num+j-1);
                end
                if (floor(event_flag/10) == 3)
                    if strncmpi(txt_1{num+j,2},'Huskies',4)
                        event_ball_number(1,num+j) = 1;
                    else
                        event_ball_number(1,num+j) = 2;
                    end
                elseif (floor(event_flag/10) == 2)||(floor(event_flag/10) == 4)
                    event_ball_number(1,num+j) = event_ball_number(1,num+j-1);
                else
                    event_ball_number(1,num+j) = 0;
                end
            end
            j = j + sum_event(1,count);
        end
        j = 1;
        for count = 1:38
            for num = 1:Match_1H_count(1,i)
                if(Huskies_control_begain == -1)&&(event_ball_number(1,num+j)==1)
                    Huskies_control_begain = num+j;
                    Huskies_control_end = -1;
                elseif(Huskies_control_end == -1)&&(event_ball_number(1,num+j)~=1)
                    Huskies_control_end =  num+j;
                    Huskies_C_R_U(1,count) = Huskies_C_R_U(1,count)+(number_1(Huskies_control_end,6) - number_1(Huskies_control_begain,6));
                    Huskies_control_begain = -1;
                end
                if(Opponent_control_begain == -1)&&(event_ball_number(1,num+j)==2)
                    Opponent_control_begain = num+j;
                    Opponent_control_end = -1;
                elseif(Opponent_control_end == -1)&&(event_ball_number(1,num+j)~=2)
                    Opponent_control_end =  num+j;
                    Opponent_C_R_U(1,count) = Opponent_C_R_U(1,count)+(number_1(Opponent_control_end,6) - number_1(Opponent_control_begain,6));
                    Opponent_control_begain = -1;
                end
            end
            j = j + Match_1H_count(1,i);
            for num = 1:(Match_2H_count(1,i)-Match_1H_count(1,i))
                if(Huskies_control_begain == -1)&&(event_ball_number(1,num+j)==1)
                    Huskies_control_begain = num+j;
                    Huskies_control_end = -1;
                elseif(Huskies_control_end == -1)&&(event_ball_number(1,num+j)~=1)
                    Huskies_control_end =  num+j;
                    Huskies_C_R_D(1,count) = Huskies_C_R_D(1,count)+(number_1(Huskies_control_end,6) - number_1(Huskies_control_begain,6));
                    Huskies_control_begain = -1;
```

```
            end

            if(Opponent_control_begain == -1)&&(event_ball_number(1,num+j)==2)
                Opponent_control_begain = num+j;
                Opponent_control_end = -1;
            elseif(Opponent_control_end == -1)&&(event_ball_number(1,num+j)~=2)
                Opponent_control_end =  num+j;
                Opponent_C_R_D(1,count) = Opponent_C_R_D(1,count)+(number_1(Opponent_control_end,6) - number_1(Opponent_control_begain,6));
                Opponent_control_begain = -1;
            end
        end
        Huskies_C_R_S(1,count) = Huskies_C_R_U(1,count) + Huskies_C_R_D(1,count);
        Opponent_C_R_S(1,count) = Opponent_C_R_U(1,count) + Opponent_C_R_D(1,count);
        %First half possession
        Huskies_C_U_rate(1,count) = Huskies_C_R_U(1,count)/(Huskies_C_R_U(1,count)+Opponent_C_R_U(1,count));
        Opponent_C_U_rate(1,count) = Opponent_C_R_U(1,count)/(Huskies_C_R_U(1,count)+Opponent_C_R_U(1,count));
        %Possession in the second half
        Huskies_C_D_rate(1,count) = Huskies_C_R_D(1,count)/(Huskies_C_R_D(1,count)+Opponent_C_R_D(1,count));
        Opponent_C_D_rate(1,count) = Opponent_C_R_D(1,count)/(Huskies_C_R_D(1,count)+Opponent_C_R_D(1,count));
        %Total possession
        Huskies_C_S_rate(1,count) = Huskies_C_R_S(1,count)/(Huskies_C_R_S(1,count)+Opponent_C_R_S(1,count));
        Opponent_C_S_rate(1,count) = Opponent_C_R_S(1,count)/(Huskies_C_R_S(1,count)+Opponent_C_R_S(1,count));
        j = j + (Match_2H_count(1,i)-Match_1H_count(1,i));
    end
    %% Huskies all players show
    figure(1);
    plot(Huskies_map_x{1,1}(1,:),Huskies_map_y{1,1}(1,:),'o');
    hold on;
    %Draw weights
    for i=1:Huskies_team_num(1,1)
        for j=i:Huskies_team_num(1,1)
            if Huskies_team_graph{1,1}(i,j)~=0
                c=num2str(Huskies_team_graph{1,1}(i,j));            %Convert the weight in the matrix to character type
                text((Huskies_map_x{1,1}(1,i)+Huskies_map_x{1,1}(1,j))/2,(Huskies_map_y{1,1}(1,i)+Huskies_map_y{1,1}(1,j))/2,c,'Fontsize',10);  %Show weight of edge
                line([Huskies_map_x{1,1}(1,i) Huskies_map_x{1,1}(1,j)],[Huskies_map_y{1,1}(1,i) Huskies_map_y{1,1}(1,j)]);      %Connection
            end
            text(Huskies_map_x{1,1}(1,i),Huskies_map_y{1,1}(1,i),num2str(Huskies_pixel_info{1,1}{i,5}),'Fontsize',14,'color','r');   %Display the sequence number of the point
        end
    end
    title('Opponent all players show');
    %% Opponent all players show
    figure(2);
    plot(Opponent_map_x{1,1}(1,:),Opponent_map_y{1,1}(1,:),'o');
    hold on;
    for i=1:Opponent_team_num(1,1)
```

```
            for j=i:Opponent_team_num(1,1)
                if Opponent_team_graph{1,1}(i,j)~=0
                    c=num2str(Opponent_team_graph{1,1}(i,j));

                    text((Opponent_map_x{1,1}(1,i)+Opponent_map_x{1,1}(1,j))/2,(Opponent_map_y{1,1}(1,i)+Opponent_map_y{1,1}(1,j))/2,c,'Fontsize',10);
                    line([Opponent_map_x{1,1}(1,i) Opponent_map_x{1,1}(1,j)],[Opponent_map_y{1,1}(1,i) Opponent_map_y{1,1}(1,j)]);
                end

                text(Opponent_map_x{1,1}(1,i),Opponent_map_y{1,1}(1,i),num2str(Opponent_pixel_info{1,1}{i,5}),'Fontsize',14,'color','r');
            end
        end
        title('Opponent all players show');
        %% Huskies whole field display initialization
        Huskies_map_value = cell(1,2);
        Huskies_w_line = zeros(1,Huskies_team_num(1,1));
        graph_mat = Huskies_team_graph{1,1};
        Huskies_map_value{1,1} = Huskies_map_x{1,1};
        Huskies_map_value{1,2} = Huskies_map_y{1,1};
        %% Huskies key members display
        for x1 = 1:Huskies_team_num(1,1)    %Process weight matrix
            for x2 = 1:Huskies_team_num(1,1)
                if graph_mat(x1,x2) <= 6
                   graph_mat(x1,x2) = 0;
                end
            end
        end
        for x1 = 1:Huskies_team_num(1,1)    %Query how many weight lines each person has vertical count
            for x2 = 1:Huskies_team_num(1,1)
                if (graph_mat(x1,x2) ~= 0)&&(x1~=x2)
                   Huskies_w_line(1,x1) = Huskies_w_line(1,x1)+1;
                end
            end
        end
        for i = 1:Huskies_team_num(1,1)    %Query how many weight lines each person has vertical count
            if(Huskies_w_line(1,i) == 0)
                Huskies_map_value{1,1}(1,i) = -1;%not draw this point
                Huskies_map_value{1,2}(1,i) = -1;
            end
        end
        figure(3);plot(Huskies_map_value{1,1}(1,:),Huskies_map_value{1,2}(1,:),'o');

        axis([0 100 0 100]);hold on;
        for i=1:Huskies_team_num(1,1)
            for j=i:Huskies_team_num(1,1)
                if graph_mat(i,j)~=0
                    c=num2str(graph_mat(i,j));
                    text((Huskies_map_value{1,1}(1,i)+Huskies_map_value{1,1}(1,j))/2,(Huskies_map_value{1,2}(1,i)+Huskies_map_value{1,2}(1,j))/2,c,'Fontsize',10);
                    line([Huskies_map_value{1,1}(1,i) Huskies_map_value{1,1}(1,j)],[Huskies_map_value{1,2}(1,i) Huskies_map_value{1,2}(1,j)]);
                end
                if Huskies_w_line(1,i) ~= 0
```

```
                text(Huskies_map_value{1,1}(1,i),Huskies_map_value{1,2}(1,i),num2str(Huskies_pixel_info{1,1}{i,5}),'Fontsize',14,'color','r');
            end
        end
    end
    title('Huskies key members display');
    %% Opponen key members init
    Opponent_map_value = cell(1,2);
    Opponent_w_line = zeros(1,Opponent_team_num(1,1));
    graph_mat = Opponent_team_graph{1,1};
    Opponent_map_value{1,1} = Opponent_map_x{1,1};
    Opponent_map_value{1,2} = Opponent_map_y{1,1};
    %% Opponen key members display
    for x1 = 1:Opponent_team_num(1,1)
        for x2 = 1:Opponent_team_num(1,1)
            if graph_mat(x1,x2) <= 3
               graph_mat(x1,x2) = 0;
            end
        end
    end
    for x1 = 1:Opponent_team_num(1,1)
        for x2 = 1:Opponent_team_num(1,1)
            if (graph_mat(x1,x2) ~= 0)&&(x1~=x2)
               Opponent_w_line(1,x1) = Opponent_w_line(1,x1)+1;
            end
        end
    end
    for i = 1:Opponent_team_num(1,1)
        if(Opponent_w_line(1,i) == 0)||(Opponent_pixel_info{1,1}{i,5}==11)
            Opponent_map_value{1,1}(1,i) = -1;
            Opponent_map_value{1,2}(1,i) = -1;
        end
    end
    figure(4);
    plot(Opponent_map_value{1,1}(1,:),Opponent_map_value{1,2}(1,:),'o');
    axis([0 100 0 100]);
    hold on;
    for i=1:Opponent_team_num(1,1)
        for j=i:Opponent_team_num(1,1)
            if (graph_mat(i,j)~=0)&&(Opponent_pixel_info{1,1}{i,5}~=11)
                c=num2str(graph_mat(i,j));
                text((Opponent_map_value{1,1}(1,i)+Opponent_map_value{1,1}(1,j))/2,(Opponent_map_value{1,2}(1,i)+Opponent_map_value{1,2}(1,j))/2,c,'Fontsize',10);
                line([Opponent_map_value{1,1}(1,i) Opponent_map_value{1,1}(1,j)],[Opponent_map_value{1,2}(1,i) Opponent_map_value{1,2}(1,j)]);
            end
            if (Opponent_w_line(1,i) ~= 0)&&(Opponent_pixel_info{1,1}{i,5}~=11)
                text(Opponent_map_value{1,1}(1,i),Opponent_map_value{1,2}(1,i),num2str(Opponent_pixel_info{1,1}{i,5}),'Fontsize',14,'color','r');
            end
        end
    end
    title('Opponen key members display');
    figure(5); bar3(Huskies_graph_z{1,2});
    title('Huskies_close'); xlabel('x'); ylabel('y'); zlabel('z');
    figure(6); bar3(Opponent_graph_z{1,2});
```

```
title('Opponent_close'); xlabel('x'); ylabel('y'); zlabel('z');
%% Thermal chart
Huskies_Thermal_chart = zeros(102,102);
for num = 2:hang_1
        if (event_attack_number(1,num) == 1)
            if ~isnan(number_1(num-1,9))
                Huskies_Thermal_chart((number_1(num-1,9)+1) , number_1(num-1,10)+1) =Huskies_Thermal_chart(number_1(num-1,9)+1 ,number_1(num-1,10)+1) + 1 ;
            end
            if ~isempty(txt_1{num,4})
                if ~isnan(number_1(num-1,9))
                    Huskies_Thermal_chart(number_1(num-1,11)+1 , number_1(num-1,12)+1) =Huskies_Thermal_chart(number_1(num-1,11)+1 , number_1(num-1,12)+1) + 1 ;
                end
            end
        end
end
Huskies_Thermal_chart(1,1) = 0;
Huskies_Thermal_chart(101,101) = 0;
Huskies_Thermal_chart(101,1) = 0;
figure(7);
[X,Y]=meshgrid(linspace(1,102),linspace(1,102));
subplot(1,1,1);
pcolor(Huskies_Thermal_chart);
title('Thermal_chart');hold on;
```