Development of SOM algorithm for Relationship between Roles and Individual's Role in Rugby 2nd Reports: University Rugby teams analysis using Physical and Psychological data

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Abstract

Victory or defeat in team sports depends on each player's technique, physical strength, and psychological condition. It follows that team performance depends on the player's adaptation to (suitability for) a certain role (position in the team) and the relationships between different roles. We assume that team performance is related to physical and psychological features. Many researchers have proposed that physical features determine a player's suitability for a position. Psychological features have also been researched as factors of position adaptation. However, each feature has been investigated independently. The present research aims to develop a clustering method that considers both physical and psychological features in judging an individual's role and adaptation in the game. This paper reports the concept of the algorithm and result of analysis using both physical data and psychological data.

Keywords: clustering, data mining, self-organizing map

1. Introduction

Victory or defeat in team sports depends on each player's individual technique, physical strength, and psychological condition. Similarly, it can be said that the suitability of an individual to a certain position in the team affects the team's performance.

In previous research, Barry and Cureton [1], Nicks and Fleishman [2], Larson [3], McCloy and Young [4] and others clustered physical features and conducted factor analysis in investigating sports performance. In Japan, Tokunaga studied the diagnosis criteria for athletic adaptation (i.e., suitability) in sports [5]. These works showed that physical features are one of the strongest factors determining athletic adaptation. However, Matsuda [6] showed that an athlete, no matter how good his/her physical features, is not athletically suited to team sports without having good motivation in terms of setting goals and training. That is to say, for an individual or team to be successful, a player needs to have both good physical features (e.g., techniques, balance, height, and weight) and good psychological features. For example, Saijo [7] presented the psychological features of Japanese and New Zealand rugby players.

In this way, the suitability of a player in a certain position and the relationships between different positions in team sports are related to physical and psychological features. As it stands now, a coach or selector decides the player suitability and relationships between positions him/herself. However, does it follow that good decisions are made? Previous research has not clarified athlete adaptation to positions and relationships

between positions considering both physical and psychological features.

In the present study, we develop a clustering algorithm for positioning adaptation and relationships in team sports. This paper reports results of analysis using both physical data analysis and psychological data.

2. Research plan and method

2.1. *Selection about sport and data*

We apply a team-sport clustering algorithm to rugby. Rugby is selected because a rugby team has a large variety of positions and player attributes. A rugby game is called a match. It is a competition between two teams. Each match lasts for 80 minutes plus time added to account for injuries and stoppages during the match. A match consists of two halves of 40 minutes each. The team with the greater number of points at the end of the match wins. Normally, a rugby team has a maximum of 15 players on the field, and seven substitutes. Each player has a specialized position. There are eight forwards, numbered 1 to 8, and seven backs, numbered 9 to 15. Player number 1 is a prop (PR), number 2 is the hooker, number 3 is another prop (PR), numbers 4 and 5 are locks (LOs), number 6 is the blindside flanker (FL), number 7 is the open-side flanker, number 8 is the "number 8" (No. 8), number 9 is the scrum-half (SH), number 10 is the fly-half (or stand-off, SO), number 11 is the left wing (WTB), number 12 is the inside center (CTB), number 13 is the outside center (CTB), number 14 is the right wing (WTB) and number 15 is the fullback (FB).

2.2. *Physical features*

Physical data of members of the N university rugby club were recorded in 2014. The N University rugby club in 2014 comprised 56 students (14 fourth-grade students, 14 third-grade students, 12 second-grade students and 16 first-grade students). There were 32 forwards (FWs) and 24 backs (BKs).

Physical features recorded were height [cm], weight [kg], body fat [%], neck length [cm], brachium length [cm] (R: right and L: left), chest circumstance [cm], waist circumstance [cm], hip circumstance [cm], length of thigh (R, L) [cm], length of calf (R, L) [cm], anteflexion while standing (flexibility) [negative value, cm], number of abdominal crunches completed in 30 s, bench-press weight [kg], number of squats completed in 30 [sec], number of chin-ups completed in one effort, and the distance run in 7 minutes [m]. The data set thus had 19 physical dimensions. Some members played more than one position (Therefore, number of the data is overlapping). There were 12 PRs, 10 LOs, 12 FLs, six No. 8s, six SHs, five SOs, 10 CTBs, seven WTBs and eight FBs.

2.3. *Psychological data*

Psychological data of members of the N rugby club were recorded in 2014. Psychological features measured were those of the Diagnostic Inventory of Psychological Competitive Ability for Athletes (DIPCA.3) [8].

DIPCA.3 measures 12 types of psychological ability in a 48-item questionnaire. DIPCA.3 is often used before mental training, because it reveals athletic strengths and weaknesses. The DIPCA.3 check sheet consists of 48 questions that measure psychological ability and four questions that measure reliability. These questions have already been analyzed by good–poor analysis (G-P analysis), and the answers provide 12 criteria relating to five factors. The factors are motivation in sport, mental stability and concentration, confidence, operation capability and cooperativeness. Additionally, we measure the reliability of the answers by comparing answers to similar questions. To examine these factors in detail, 12 criteria are described. Motivation in sport consists of four criteria: endurance, fighting spirit, self-realization motivation and motivation to win. Mental stability and concentration consist of three criteria: the ability to relax, capacity to concentrate and self-control. Confidence consists of two criteria: determination and confidence. Operation capability consists of two criteria: predictive capability and judgment. Cooperativeness has only one criterion, which is simply described as cooperativeness. DIPCA.3 provides a total score (ability). Each criterion is scored, and the score of each factor is the sum of scores for the related criteria. The total score is calculated by summing the score for each factor.

2.4. *Algorithms of this Clustering system*

This clustering algorithm is reported by 1st reports [9].

3. Experimental Result

The data of the feature map obtained by putting the data group in the SOM is shown in Fig.1. Fig.1 shows the feature map of 10x10. The position and data number of personal data are attached to the best matching unit (BMU) as labels. The color of the feature map indicates the distance from the neighboring unit, which means that the distance between the units is far away from blue to red. As shown in Fig.1, forward (FW) is distributed in the upper part of the feature map, and members in the

position of Backs (BK) gather in the lower part. Consider psychological feature quantities input as input

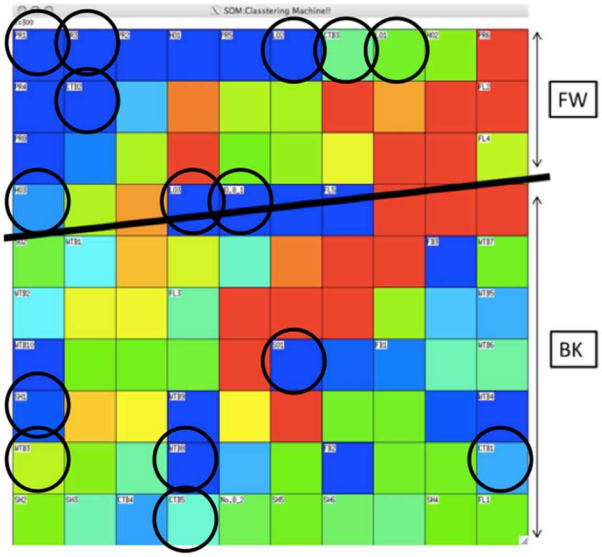

Fig.1 Feature map of experimental result (total score)

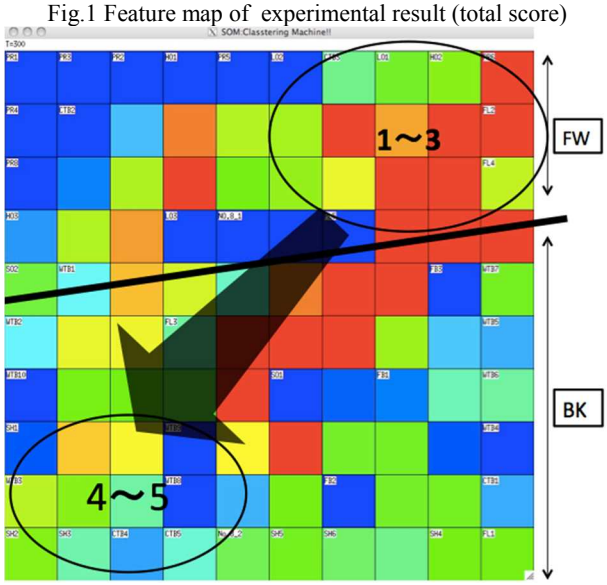

Fig.2 Feature map of experimental result (Cooperativeness)

data. When the overall score of DIPCA.3 (total score is not included in the input data) is examined, the overall score will be higher as it goes to the lower left. Based on the above results, it is considered using using physical characteristics and psychological characteristics that the overall superiority of positioning of this team by the supervisor.

Fig.2 shows the results of evaluation of psychological analysis on cooperativeness. The feature map uses the same map in Fig.1. Therefore, the individual labeling position is the same as Fig.1. For items on cooperativeness, low-level players are gathered in the upper right, and higher-level players are arranged as they go to the lower right. For this reason, in this team, highly level athletes on cooperativeness are often assigned to BK and it is understood that low players are assigned to FW. In other words, coach can analyze the psychological state well and find out that is allocating positions.

As shown in Fig. 3, the unit which is denoted by black circle indicates a regular member. Analysis of this result shows that athletes with high psychological ability values are selected as regular members. In other words, the coach knows that for the selection of regular members in this team, there is a tendency to comprehensively select high level psychological players and high cooperativeness level players as psychological conditions.

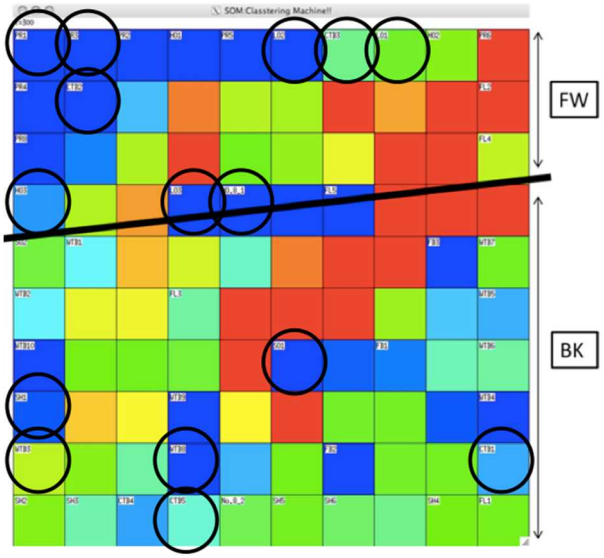

Fig.3 regular position in Feature maps

4. Summary

In this paper, we experimented on clustering machine using SOM with the goal of processing data on individual physical characteristics and psychological features in group sports. In this research, we developed a clustering device that takes physical features and psychological features into 46 input data, and analyzing

the results. The feature map is the result of clustering, can be largely categorized into FW and BK, and can clarify psychological features and physical features. And, we can find how coach decide the position and regular members. As a future works, for developing a clustering device, if we can use more detail input data (add the dimensions) can perform more precise diagnosis.

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