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Application of fuzzy soft set theory and Hungarian method for assigning player's position

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Abstract

In this analysis an application of integrated fuzzy soft set theory and Hungarian method in MCDM problem is used to evaluate the ranking order of players and their position in the game. The problem's objective is to select an each player's suitable position out of seven positions namely Goal Shooter, Goal Attack, Wing Attack, Centre, Wing Defence, Goal Defence, and Goal Keeper. From the comprehensive decision matrix, Hungarian method is applied to assign a suitable position to each player.

Keywords

Hungarian method, Performance evaluation, Fuzzy soft set, Comprehensive decision matrix.

AMS Subject Classification

03E72.

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Contents

1. Introduction

Molodtsov originated the soft set's concept [1]. And in several various directions he applied this theory [1,2,3]. After that the notions of soft number, soft integral, soft derivative, etc. were defined in [4]. Soft set theory were applied in many different fields. The Assignment problem was first analysed and explained by Kuhn. In 1955, Kuhn explains and illustrated the Hungarian method for the Assignment problem [9]. In 1957, Munkres had given the Assignment and Transportation problems algorithm [10]. In 2008, Baeva et.al structured MCDM for selection and assignment of players in game [4]. In 2003, Baker et.al analysed sport-specific practice and the development of expert Decision-Making in Ball Sports [6]. In 2003, Nauss dealt with the generalized Assignment problem with illustrative example [11]. Odior determined feasible solutions of multi criteria Assignment problem in 2010 [12]. In 1987, Oliver et.al examined the permutation cross over operators on the Traveling salesman problem [13].

Further sections are organized as follows. In Section 2 and 3, we propose an integrated technique and given an application in MCDM problem for selecting suitable position for each player. The conclusion is included in Section 4.

2. New Approach for Solving Multi-Criteria Decision Making Problem

Sophia Porchelvi et.al [6] modified the fuzzy soft set and Castello [8] presented the Hungarian method. With the help of their explanation we have integrated fuzzy soft set and Hungarian method. The ranking order of players and their positions were solved and assigned by the following algorithm.

- The performance evaluations for seven players are given by the selection committee faculties as matrices.
- The corresponding entries of all matrices average are calculated.
- To get the comprehensive decision matrix, multiply the weightage of the criteria.
- At last, Hungarian method is used to assign each player's position in game.

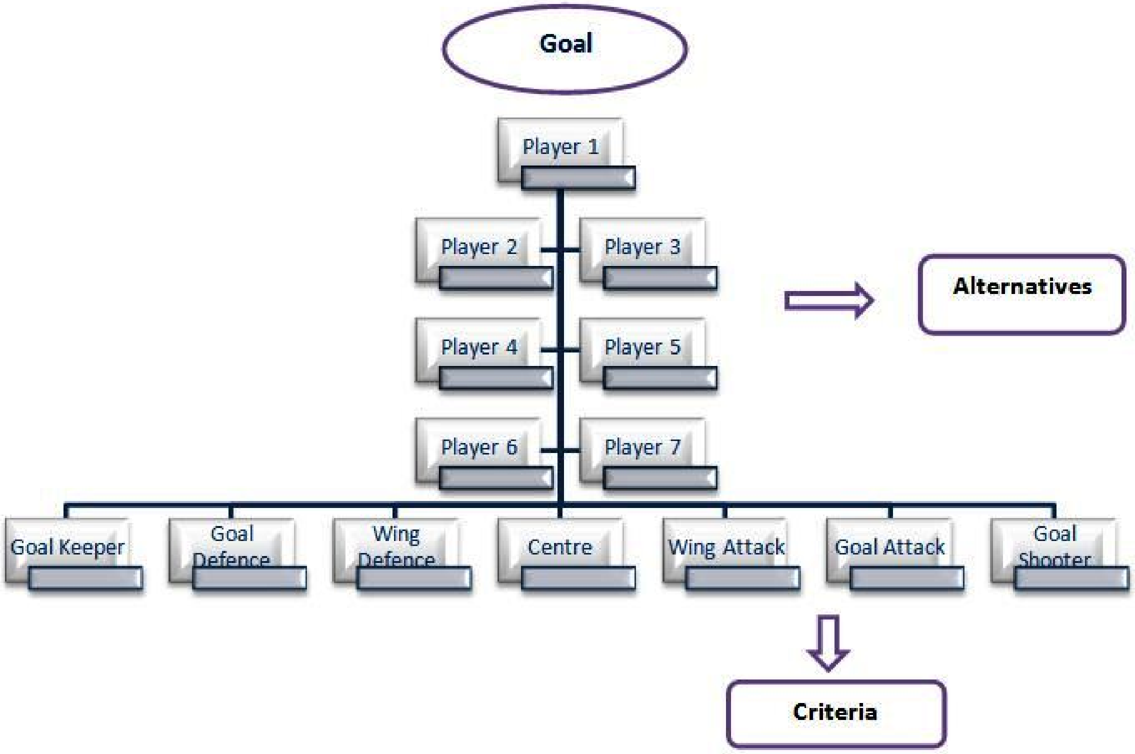

Figure 1. Hierarchical structure of criteria and alternatives

3. The Application of MCDM problem

The player's positions are the criteria of the problem and it is denoted by $h_1, h_2, h_3, h_4, h_5, h_6, h_7$ respectively. Three selection committee members (F_1, F_2, F_3) are the decision makers.

The information about the each player's positions is provided by the decision makers based on the criteria. $P_1, P_2, P_3, P_4, P_5, P_6, P_7$ are the alternatives (seven players) of the problem. The information of decision makers, F_1, F_2, F_3 are given below. The fuzzy soft set of (C_1, P)

$$C_1(P_1) = \left\{ \frac{h_1}{0.50}, \frac{h_2}{0.20}, \frac{h_3}{0.42}, \frac{h_4}{0.20}, \frac{h_5}{0.60}, \frac{h_6}{0.73}, \frac{h_7}{0.45} \right\}$$

$$C_1(P_2) = \left\{ \frac{h_1}{0.53}, \frac{h_2}{0.60}, \frac{h_3}{0.40}, \frac{h_4}{0.60}, \frac{h_5}{0.35}, \frac{h_6}{0.72}, \frac{h_7}{0.81} \right\}$$

$$C_1(P_3) = \left\{ \frac{h_1}{0.70}, \frac{h_2}{0.80}, \frac{h_3}{0.73}, \frac{h_4}{0.90}, \frac{h_5}{0.40}, \frac{h_6}{0.56}, \frac{h_7}{0.62} \right\}$$

$$C_1(P_4) = \left\{ \frac{h_1}{0.51}, \frac{h_2}{0.60}, \frac{h_3}{0.50}, \frac{h_4}{0.60}, \frac{h_5}{0.31}, \frac{h_6}{0.77}, \frac{h_7}{0.80} \right\}$$

$$C_1(P_5) = \left\{ \frac{h_1}{0.62}, \frac{h_2}{0.71}, \frac{h_3}{0.63}, \frac{h_4}{0.74}, \frac{h_5}{0.86}, \frac{h_6}{0.57}, \frac{h_7}{0.72} \right\}$$

$$C_1(P_6) = \left\{ \frac{h_1}{0.77}, \frac{h_2}{0.55}, \frac{h_3}{0.57}, \frac{h_4}{0.67}, \frac{h_5}{0.78}, \frac{h_6}{0.44}, \frac{h_7}{0.51} \right\}$$

$$C_1(P_7) = \left\{ \frac{h_1}{0.83}, \frac{h_2}{0.47}, \frac{h_3}{0.31}, \frac{h_4}{0.39}, \frac{h_5}{0.54}, \frac{h_6}{0.36}, \frac{h_7}{0.27} \right\}$$

The fuzzy soft set of (C_2, P),

$$C_2(P_1) = \left\{ \frac{h_1}{0.52}, \frac{h_2}{0.27}, \frac{h_3}{0.50}, \frac{h_4}{0.30}, \frac{h_5}{0.57}, \frac{h_6}{0.72}, \frac{h_7}{0.41} \right\}$$

$$C_2(P_2) = \left\{ \frac{h_1}{0.40}, \frac{h_2}{0.62}, \frac{h_3}{0.37}, \frac{h_4}{0.62}, \frac{h_5}{0.39}, \frac{h_6}{0.77}, \frac{h_7}{0.83} \right\}$$

$$C_2(P_3) = \left\{ \frac{h_1}{0.80}, \frac{h_2}{0.85}, \frac{h_3}{0.90}, \frac{h_4}{0.90}, \frac{h_5}{0.41}, \frac{h_6}{0.52}, \frac{h_7}{0.60} \right\}$$

$$C_2(P_4) = \left\{ \frac{h_1}{0.40}, \frac{h_2}{0.60}, \frac{h_3}{0.40}, \frac{h_4}{0.62}, \frac{h_5}{0.30}, \frac{h_6}{0.67}, \frac{h_7}{0.79} \right\}$$

$$C_2(P_5) \left\{ \frac{h_1}{0.60}, \frac{h_2}{0.78}, \frac{h_3}{0.61}, \frac{h_4}{0.71}, \frac{h_5}{0.87}, \frac{h_6}{0.60}, \frac{h_7}{0.70} \right\}$$

$$C_2(P_6) = \left\{ \frac{h_1}{0.74}, \frac{h_2}{0.54}, \frac{h_3}{0.60}, \frac{h_4}{0.68}, \frac{h_5}{0.80}, \frac{h_6}{0.45}, \frac{h_7}{0.52} \right\}$$

$$C_2(P_7) = \left\{ \frac{h_1}{0.82}, \frac{h_2}{0.43}, \frac{h_3}{0.34}, \frac{h_4}{0.38}, \frac{h_5}{0.53}, \frac{h_6}{0.39}, \frac{h_7}{0.37} \right\}$$

The fuzzy soft set of (C_3, P)

$$C_3(P_1) = \left\{ \frac{h_1}{0.54}, \frac{h_2}{0.30}, \frac{h_3}{0.47}, \frac{h_4}{0.32}, \frac{h_5}{0.62}, \frac{h_6}{0.79}, \frac{h_7}{0.54} \right\}$$

$$C_3(P_2) = \left\{ \frac{h_1}{0.42}, \frac{h_2}{0.65}, \frac{h_3}{0.47}, \frac{h_4}{0.68}, \frac{h_5}{0.47}, \frac{h_6}{0.75}, \frac{h_7}{0.80} \right\}$$

$$C_3(P_3) = \left\{ \frac{h_1}{0.97}, \frac{h_2}{0.91}, \frac{h_3}{0.95}, \frac{h_4}{0.98}, \frac{h_5}{0.44}, \frac{h_6}{0.62}, \frac{h_7}{0.67} \right\}$$

$$C_3(P_4) = \left\{ \frac{h_1}{0.40}, \frac{h_2}{0.63}, \frac{h_3}{0.46}, \frac{h_4}{0.68}, \frac{h_5}{0.40}, \frac{h_6}{0.67}, \frac{h_7}{0.73} \right\}$$

$$C_3(P_5) = \left\{ \frac{h_1}{0.65}, \frac{h_2}{0.74}, \frac{h_3}{0.67}, \frac{h_4}{0.70}, \frac{h_5}{0.84}, \frac{h_6}{0.63}, \frac{h_7}{0.76} \right\}$$

$$C_3(P_6) = \left\{ \frac{h_1}{0.79}, \frac{h_2}{0.53}, \frac{h_3}{0.63}, \frac{h_4}{0.69}, \frac{h_5}{0.87}, \frac{h_6}{0.41}, \frac{h_7}{0.55} \right\}$$

$$C_3(P_7) = \left\{ \frac{h_1}{0.81}, \frac{h_2}{0.45}, \frac{h_3}{0.37}, \frac{h_4}{0.40}, \frac{h_5}{0.51}, \frac{h_6}{0.43}, \frac{h_7}{0.31} \right\}$$

Then, the matrix representation of the above three fuzzy soft sets $(C_1, P), (C_2, P)$ and (C_3, P) are

$(C_1, P) =$

$$\begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \\ p_4 \\ p_5 \\ p_6 \\ p_7 \end{array} \begin{array}{c} \begin{array}{ccccccc} h_1 & h_2 & h_3 & h_4 & h_5 & h_6 & h_7 \end{array} \\ \begin{bmatrix} 0.50 & 0.20 & 0.42 & 0.20 & 0.60 & 0.73 & 0.45 \\ 0.53 & 0.60 & 0.40 & 0.60 & 0.35 & 0.72 & 0.81 \\ 0.70 & 0.80 & 0.73 & 0.90 & 0.40 & 0.56 & 0.62 \\ 0.51 & 0.60 & 0.50 & 0.60 & 0.31 & 0.77 & 0.80 \\ 0.62 & 0.71 & 0.63 & 0.74 & 0.86 & 0.57 & 0.72 \\ 0.77 & 0.55 & 0.57 & 0.67 & 0.78 & 0.44 & 0.51 \\ 0.83 & 0.47 & 0.31 & 0.39 & 0.54 & 0.36 & 0.27 \end{bmatrix} \end{array}$$

$(C_2, P) =$

$$\begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \\ p_4 \\ p_5 \\ p_6 \end{array} \begin{array}{c} \begin{array}{ccccccc} h_1 & h_2 & h_3 & h_4 & h_5 & h_6 & h_7 \end{array} \\ \begin{bmatrix} 0.52 & 0.27 & 0.50 & 0.30 & 0.57 & 0.72 & 0.41 \\ 0.40 & 0.62 & 0.37 & 0.62 & 0.39 & 0.77 & 0.83 \\ 0.80 & 0.85 & 0.90 & 0.90 & 0.41 & 0.52 & 0.60 \\ 0.40 & 0.60 & 0.40 & 0.62 & 0.30 & 0.67 & 0.79 \\ 0.60 & 0.78 & 0.61 & 0.71 & 0.87 & 0.60 & 0.70 \\ 0.74 & 0.54 & 0.60 & 0.68 & 0.80 & 0.45 & 0.52 \end{bmatrix} \end{array}$$

$(C_3, P) =$

$$\begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \\ p_4 \\ p_5 \\ p_6 \\ p_7 \end{array} \begin{array}{c} \begin{array}{ccccccc} h_1 & h_2 & h_3 & h_4 & h_5 & h_6 & h_7 \end{array} \\ \begin{bmatrix} 0.54 & 0.30 & 0.47 & 0.32 & 0.62 & 0.79 & 0.54 \\ 0.42 & 0.65 & 0.47 & 0.68 & 0.47 & 0.75 & 0.80 \\ 0.97 & 0.91 & 0.95 & 0.98 & 0.44 & 0.62 & 0.67 \\ 0.40 & 0.63 & 0.46 & 0.68 & 0.40 & 0.67 & 0.73 \\ 0.65 & 0.74 & 0.67 & 0.70 & 0.84 & 0.63 & 0.76 \\ 0.79 & 0.53 & 0.63 & 0.69 & 0.87 & 0.41 & 0.55 \\ 0.81 & 0.45 & 0.37 & 0.40 & 0.51 & 0.43 & 0.31 \end{bmatrix} \end{array}$$

We get the performance evaluation matrix by the average of above three matrices.

$C(P) =$

$$\begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \\ p_4 \\ p_5 \\ p_6 \\ p_7 \end{array} \begin{array}{c} \begin{array}{ccccccc} h_1 & h_2 & h_3 & h_4 & h_5 & h_6 & h_7 \end{array} \\ \begin{bmatrix} 0.52 & 0.26 & 0.46 & 0.27 & 0.59 & 0.75 & 0.47 \\ 0.45 & 0.62 & 0.41 & 0.63 & 0.40 & 0.75 & 0.81 \\ 0.82 & 0.85 & 0.86 & 0.93 & 0.42 & 0.57 & 0.63 \\ 0.44 & 0.61 & 0.45 & 0.63 & 0.34 & 0.70 & 0.77 \\ 0.62 & 0.74 & 0.64 & 0.72 & 0.86 & 0.60 & 0.73 \\ 0.77 & 0.54 & 0.60 & 0.68 & 0.82 & 0.43 & 0.53 \\ 0.82 & 0.45 & 0.34 & 0.39 & 0.53 & 0.39 & 0.32 \end{bmatrix} \end{array}$$

The criteria's weightage is given by the coacher as

$$W = \begin{array}{c} \begin{array}{ccccccc} h_1 & h_2 & h_3 & h_4 & h_5 & h_6 & h_7 \end{array} \\ [0.29 \quad 0.10 \quad 0.08 \quad 0.06 \quad 0.08 \quad 0.10 \quad 0.29] \end{array}$$

Then we get the comprehensive decision matrix D by multiplying the criteria's weightage in the performance evaluation matrix.

$D =$

$$\begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \\ p_4 \\ p_5 \\ p_6 \\ p_7 \end{array} \begin{array}{c} \begin{array}{ccccccc} h_1 & h_2 & h_3 & h_4 & h_5 & h_6 & h_7 \end{array} \\ \begin{bmatrix} 0.1508 & 0.026 & 0.0368 & 0.0162 & 0.0472 & 0.075 & 0.1363 \\ 0.1305 & 0.062 & 0.0328 & 0.0378 & 0.032 & 0.075 & 0.2349 \\ 0.2378 & 0.085 & 0.0688 & 0.0558 & 0.0336 & 0.057 & 0.1827 \\ 0.1276 & 0.061 & 0.036 & 0.0378 & 0.0272 & 0.070 & 0.2233 \\ 0.1798 & 0.074 & 0.0512 & 0.0432 & 0.0688 & 0.060 & 0.2117 \\ 0.2233 & 0.054 & 0.048 & 0.0408 & 0.0656 & 0.043 & 0.1537 \\ 0.2378 & 0.045 & 0.0272 & 0.0234 & 0.0424 & 0.039 & 0.0928 \end{bmatrix} \end{array}$$

At the final stage of the calculation, we apply Hungarian method to assigning the each player's position. We get an optimal solution of this problem as follows,

$$\begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \\ p_4 \\ p_5 \\ p_6 \\ p_7 \end{array} \begin{array}{c} \begin{array}{ccccccc} h_1 & h_2 & h_3 & h_4 & h_5 & h_6 & h_7 \end{array} \\ \begin{bmatrix} 0.0361 & \mathbf{0} & 0.0198 & 0 & 0.0329 & 0.0566 & 0.0507 \\ 0 & 0.0202 & \mathbf{0} & 0.0058 & 0.0019 & 0.0408 & 0.1335 \\ 0.1038 & 0.0397 & 0.0325 & 0.0203 & \mathbf{0} & 0.0193 & 0.0778 \\ \mathbf{0} & 0.0221 & 0.0061 & 0.0087 & 0 & 0.0387 & 0.1248 \\ 0.0381 & 0.0210 & 0.0072 & \mathbf{0} & 0.0275 & 0.0146 & 0.0991 \\ 0.0840 & 0.0034 & 0.0064 & 0 & 0.0267 & \mathbf{0} & 0.0435 \\ 0.1159 & 0.0118 & 0.0030 & 0 & 0.0209 & 0.0134 & \mathbf{0} \end{bmatrix} \end{array}$$

Thus we assign a suitable position to each player $p_1 \to h_1, p_2 \to h_3, p_3 \to h_5, p_4 \to h_1, p_5 \to h_4, p_6 \to h_6, p_7 \to h_7$

$$\begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \\ p_4 \\ p_5 \\ p_6 \\ p_7 \end{array} \begin{array}{c} \begin{array}{ccccccc} h_1 & h_2 & h_3 & h_4 & h_5 & h_6 & h_7 \end{array} \\ \begin{bmatrix} 0.1508 & \mathbf{0.026} & 0.0368 & 0.0162 & 0.0472 & 0.075 & 0.1363 \\ 0.1305 & 0.062 & \mathbf{0.0328} & 0.0378 & 0.032 & 0.075 & 0.2349 \\ 0.2378 & 0.085 & 0.0688 & 0.0558 & \mathbf{0.0336} & 0.057 & 0.1827 \\ \mathbf{0.1276} & 0.061 & 0.036 & 0.0378 & 0.0272 & 0.070 & 0.2233 \\ 0.1798 & 0.074 & 0.0512 & \mathbf{0.0432} & 0.0688 & 0.060 & 0.2117 \\ 0.2233 & 0.054 & 0.048 & 0.0408 & 0.0656 & \mathbf{0.043} & 0.1537 \\ 0.2378 & 0.045 & 0.0272 & 0.0234 & 0.0424 & 0.039 & \mathbf{0.0928} \end{bmatrix} \end{array}$$

Hence the optimal value is equals to 0.399.

4. Conclusion

We can see that the integration of fuzzy soft set theory and Hungarian method is presented here to assign each player's position. First of all this technique brings about a series of skills tests specific to netball game. And not only for selecting the excellent team, but also assigning their positions in game. At the end, the resulting matrix is optimised by the Hungarian technique. Within a short period we can able to take a decision with the help of this approach.

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