# A Schema to Determine Basketball Defense Strategies Using a Fuzzy Expert System

CHE-CHERN LIN[1], VINCENT CHEN[2], CHENG-CHUNG YU[3], YU-CHUAN LIN[4]
National Kaohsiung Normal University[1] Shu-Te University[2],
Kao Yuan University[3], Meiho Institute of Technology[4]
Department of Industrial Technology Education[1]
116 Ho Ping First Road, Kaohsiung[1],
TAIWAN, ROC

*Abstract:* - In this paper, the authors propose a schema for a decision support system for basketball defense strategies using a fuzzy expert system. The authors introduce the original ideas for the proposed schema and the background of the basketball defense strategies. The authors also present the fuzzy input and output attributes for the fuzzy expert system according to the domain knowledge from the basketball coaches. Finally, the authors discuss the following works for implementing the fuzzy expert system.

*Key-words*: Zone defense; Decision making; Basketball defense; Fuzzy expert system.

## 1 Introduction

Traditionally basketball defense strategies are determined by the coaching staffs using their knowledge and experience. They use team statistics and the properties of their own team and the opponent team to make decisions. The team statistics are numeric data and therefore needed to be transferred to decision rules in verbal expressions. In this paper, the authors propose a schema of decision support system to determine basketball defense strategies using a fuzzy expert system. This system could imitate the thinking process of basketball coaches using predefined rules, called fuzzy if–then rules. These rules could be established by domain experts (basketball coaches) and presented in linguistic expressions. By firing these fuzzy rules, the system could suggest the defense pattern to help the coaches make their decisions.

The fuzzy expert technique is one of popular artificial intelligence methods and widely applied to different areas. People use fuzzy if –then rules to simulate human thinking process and solve the decision problems. Member functions are used to measure the similarity of the data and to transfer crisp numbers to fuzzy numbers. There are two typical membership functions are usually adopted: a triangular membership function and a trapezoidal membership function. The fuzzy inference is a mechanism to get the fuzzy results by firing the fuzzy if-then rules. The outputs of fuzzy inference are described in fuzzy expressions. In real world, people need an expression described in crisp numbers for control or expert systems. The final step for a fuzzy system is therefore the defuzzification procedure to get the crisp number for the fuzzy expression.

Fuzzy expert systems are widely used in many areas. A route choice in transportation systems using fuzzy perceptions has been presented in [1] where the authors proposed a hybrid model combining fuzzy logic and analytical hierarchy process (AHP). A fuzzy decision modeling for supply chain management has been proposed based on possibility theory [2]. A fuzzy voting schema for hardware and software fault tolerant systems has been presented where the author applied fuzzy agreeability to generate fuzzy rules [3]. A fuzzy-based path ordering algorithm for quality of service (QoS) routing in non-deterministic communication networks has been proposed to reduce the average setup time for establishing a feasibility connection [4].

In this paper, based on fuzzy inference, the authors propose a schema of a decision support system for basketball coaching strategies. The authors introduce the background of the basketball and defense types. The authors also discuss the feature selections for basketball defense coaching. Finally the authors explain the schema for the fuzzy expert system applied to basketball defense coaching.

## 2 Background
### 2.1 Basketball Court and Player Positions
An illustrative figure on basketball court is shown in Figure 1 [5,6,7]. This figure also demonstrates low post, high post and wing positions During the game,

there are five players playing on the basketball court for each team. The five players are usually numbered from players 1 to 5 according to their positions. They are described as follows [5,6,7]:

1. Player 1 (Point guard): This player is mostly the best passer and dribbler on the team and the key person to run the offense. Usually this player should know how to make a play and therefore determines where to pass the ball
2. Player 2 (Shooting guard): This player is probably one of the best shooters on the team and a good passer delivering the ball to the post players (power forward and center). The shooting guard usually plays the wing areas and is therefore called an "off guard"
3. Player 3 (Small forward): This player plays a mixed position combining the guards and the post players.
4. Player 4 (Power forward): This player is usually one of the tallest and strongest persons on the team. The player is responsible for getting rebounds in the low post and could have a lot of physical contacts with the opponent players.
5. Player 5 (Center): This player is probably the tallest person on the team and usually plays in the low post with the ability to catch different types of passes on offense. This play could be the 'last line' of defense protecting the basket from the opponents' shooting.

## 2.2 Defense Types

Two major types of defenses are usually adopted by the basketball coaches. They are a man-to-man defense and a zone defense. In the man-to-man defense, each of the defenders is assigned to defend a particular opponent. In the zone defense, each of defenders is responsible for defending a particular area. There are five major types of zone defenses according to the positions of the defenders, including 1-2-2, 2-1-2, 1-3-1, 2-3, and 3-2 zone defenses. They are shown in Figures 2 to 6 [5,6,7].

# 3 The Proposed Schema

The authors propose the input and output attributes for the fuzzy expert system. These attributes are selected according to the domain knowledge from the basketball coaches.

The input attributes are divided into two groups: a statistical group and a performance group. Each attribute in the statistical group is measured by the defense and offense statistics. Each attribute in the performance group is measured by the coaches' evaluations. Table 1 shows the input attributes of the statistical group of the fuzzy expert system. Table 2

displays the input attributes of the performance group of the fuzzy expert system.

Each attribute in the statistical group is normalized into five levels from low to high as follows:

Level 1: $m-2\delta$

Level 2: $m-\delta$

Level 3: $m$

Level 4: $m+\delta$

Level 5: $m+2\delta$

where m and $\delta$ are the mean and standard deviation of the attribute of all teams. The membership function of each attribute is established by a triangle function. Figure 7 is an example of the fuzzy input attribute of the average height where m = 2.5cm and $\delta$= 181.9cm.

Each attribute in the performance group is evaluated by the basketball coaches. Figure 8 is an example of the fuzzy input attribute of the ability of low post play.

The output of the fuzzy expert system is the selection of zone defense pattern for a basketball team. Five zone defense patterns are determined including 1-2-2, 2-1-2, 1-3-1, 2-3, and 3-2 patterns. Based on the degrees of outer-defense, the five zone defense patterns are ranged from degree 1 (the least outer-defense) to degree 5 (the most outer-defense). Figure 9 shows the fuzzy output of the expert system.

Since the zone defense pattern is determined according to the degree of the outer-defense. By the fuzzy input and output attributes mentioned above, one can design fuzzy if-then rules for the fuzzy coaching system from the domain knowledge of the basketball coaches and then perform fuzzy inference to get fuzzy results. The possible fuzzy rules should include the attributes of the statistical and performance groups of both teams (the opponent team and my team). Finally, a defuzzification procedure will be applied to get the desired crisp results. The output of the fuzzy system is therefore determined by the input attributes and the result of fuzzy inference, which is one of the five zone defense patterns.

# 4 Conclusions

The authors proposed a schema for a decision support system for basketball defense strategies using a fuzzy expert system. The authors introduced the original ideas of the proposed schema and the background of the basketball defense strategies. The authors also presented the fuzzy input and output attributes for the fuzzy expert system according to the domain knowledge from the basketball coaches. Furthermore the authors demonstrated an example of

fuzzy if-then rule for the system. Finally, the authors discussed the following works for implementing the fuzzy expert system.

## Acknowledgement

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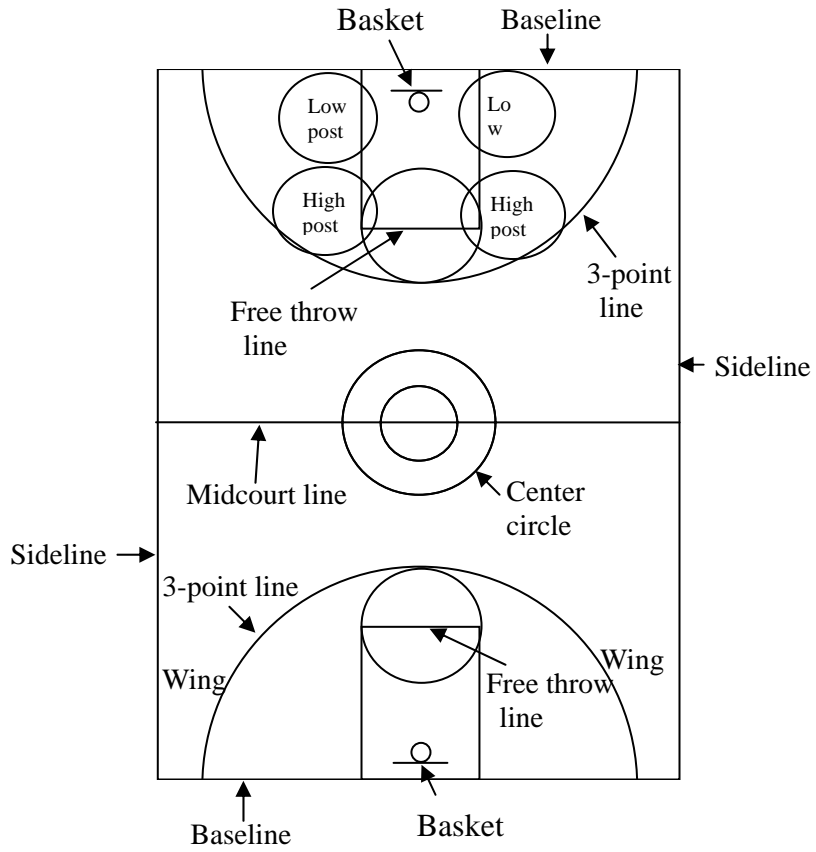
Figure 1: An illustrative figure on basketball court
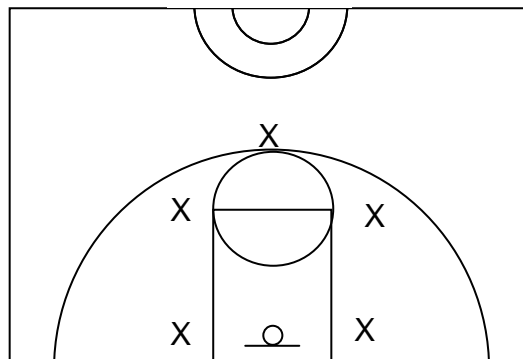(taken form [5, 6,7])



Figure 2: The 1-2-2 zone defense
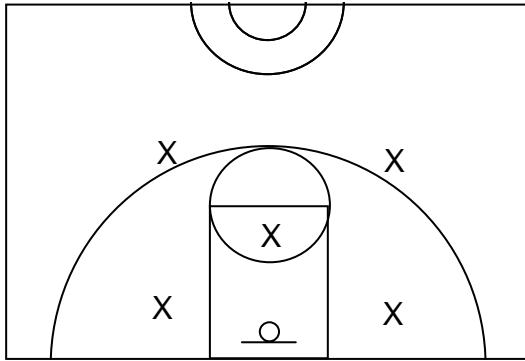(taken from [5,6,7])

Figure 3: The 2-1-2 zone defense
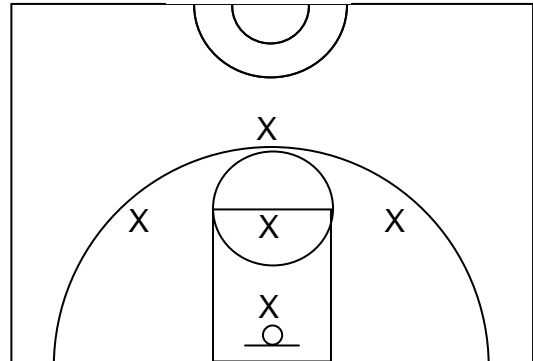(taken from [5,6,7])



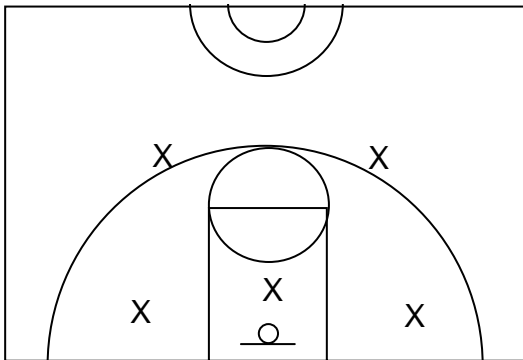Figure 4: The 1-3-1 zone defense
(taken from [5,6,7]).



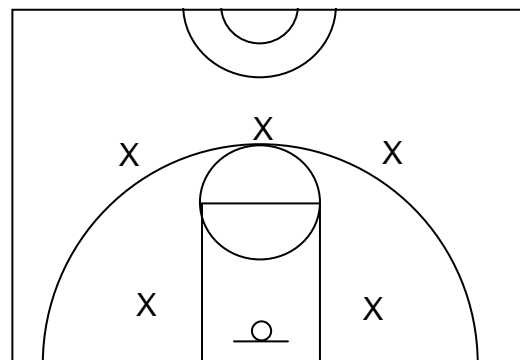Figure 5: The 2-1-2 zone defense
(taken from [5,6,7])



Figure 6: The 3-2 zone defense

Table 1: The input attributes of the statistical group.

| Opponent team | My team |
|---|---|
| The number of points earned by player 1 | Average height of the players |
| The number of points earned by player 2 | The ability of move, help and recovering of players 2 and 3 |
| The number of points earned by player 3 | The ability of help and recovering of player 5 |
| The number of points earned by player 4 | The number of defensive blocks made by player 4. |
| The number of points earned by player 5 | The number of defensive blocks made by player 5. |
| The number of steals made by player 1 | |
| The number of assistances made by player 1 | |
| The number of assistances made by player 4 | |
| The number of assistances made by player 5 | |
| Average height of the players | |

Table 2: The input attributes of the performance group

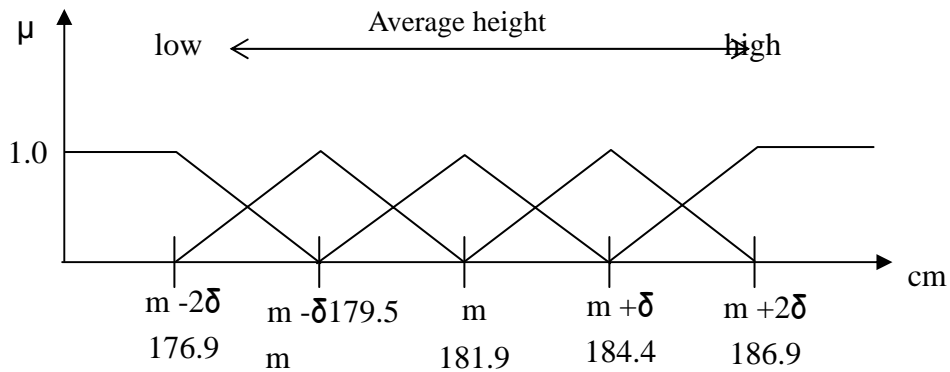| Opponent team | My team |
|---|---|
| The ability of dribbling-crossover of player 1 | The ability of pressure-defense of player 1 |
| The ability of low post play | The ability of double-team of all players |

Figure 7: An example a fuzzy input attribute of the statistical group (average height).
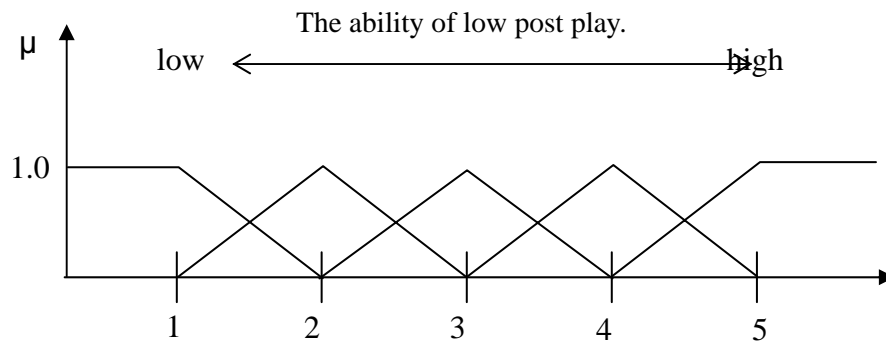


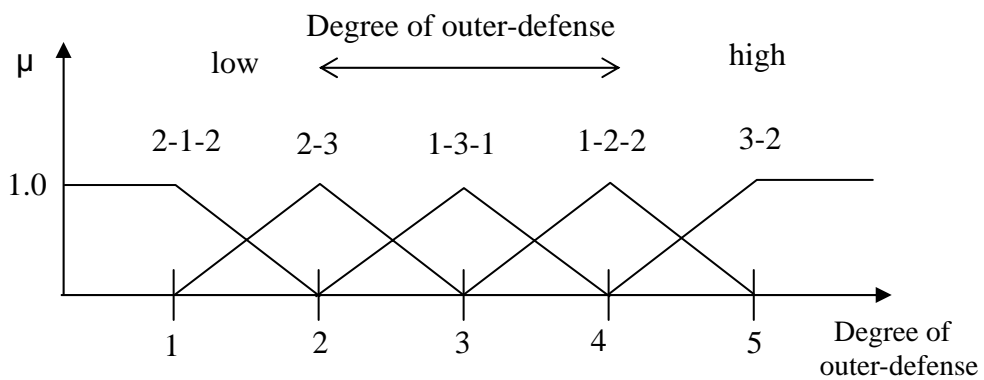Figure 8: An example of fuzzy input attribute of the performance group (the ability of low post play).



Figure 9: the fuzzy output of the expert system.