

TEMPORAL EVOLUTION OF THE GAME OF BASKETBALL IN THE NBA

Federico Cesare Cattò, Stefano Andreoli, Andrea Matteo Re

Abstract

Over the past 25 years, the game of basketball in the NBA has undergone significant tactical evolution, marked by the progressive dissolution of traditional roles. This report analyzes such transformation through a statistical classification of players, focusing on the seasons between 1997 and 2023. Using model-based clustering techniques (EDDA and MDA), we compare the role definitions across three different time periods, observing a gradual increase in misclassification error and a growing overlap in player characteristics. Our findings highlight a shift from rigid positional structures to a “roleless” approach, characterized by greater versatility and homogeneity in on-court performance. Building on the theory proposed by analyst JJ Redick, we validate through cluster analysis the emergence of three modern functional roles: ball handler, off-ball player, and big, each confirmed by distinct statistical profiles. The analysis confirms the strategic shift in the league – amplified by the rise of players like Stephen Curry – towards a more perimeter-oriented, dynamic, and efficiency-driven style of play.

1 Introduction

Basketball is a sport that has undergone constant evolution, particularly in the National Basketball Association (NBA), widely regarded as the most competitive and influential basketball league in the world. While the traditional structure of the game has long been based on five distinct player positions—point guard (PG), shooting guard (SG), small forward (SF), power forward (PF), and center (C)—recent years have seen a notable shift in how these roles are interpreted and utilized on the court.

In this report, we investigate the extent to which player roles in the NBA have transformed over the past 25 years. We aim to understand how tactical strategies, player skills, and team compositions have evolved, moving away from rigid positional definitions toward a more flexible, “roleless” style of basketball. This trend, often discussed in contemporary sports analysis, is exemplified by the rise of versatile players and a growing emphasis on perimeter shooting.

To carry out this investigation, we employ model-based classification and clustering techniques, using a dataset that spans from the 1997 to the 2023 NBA seasons. By segmenting the data into historical (1997–2002), full-range (1997–2023), and recent (2018–2023) periods, we analyze changes in classification accuracy and role distinctiveness over time. Furthermore, we examine and validate a modern theory proposed by former NBA player and analyst JJ Redick, who suggests a more functional categorization of players into three core roles: ball handler, off-ball player, and big.

Through this analysis, we seek to provide quantitative evidence of the NBA’s tactical evolution, offering insights into how statistical profiles can reflect larger strategic shifts in the game.

2 Dataset Description

The dataset used in this analysis aggregates NBA player statistics from the 1997–1998 season through the 2022–2023 season. It combines both traditional and advanced metrics, with all

numerical variables representing per-game averages over the course of each season. The dataset includes the following variables:

- **RK**: Alphabetical rank of the player.
- **Player**: Full name of the player.
- **Pos**: Position played (as officially recorded).
- **Age**: Age of the player during the respective season.
- **Tm**: Team affiliation during the season.
- **G**: Games played.
- **GS**: Games started.
- **MP**: Minutes played per game.
- **FG**, **FGA**, **FG%**: Field goals made, attempted, and shooting percentage (excluding free throws).
- **3P**, **3PA**, **3P%**: Three-point field goals made, attempted, and shooting percentage.
- **2P**, **2PA**, **2P%**: Two-point field goals made, attempted, and shooting percentage.
- **eFG%**: Effective field goal percentage, accounting for the added value of 3-point shots: $(2P + 1.5 \times 3P) / FGA$.
- **FT**, **FTA**, **FT%**: Free throws made, attempted, and shooting percentage.
- **ORB**, **DRB**, **TRB**: Offensive, defensive, and total rebounds.
- **AST**: Assists.
- **STL**: Steals.
- **BLK**: Blocks.
- **TOV**: Turnovers.
- **PF**: Personal fouls.
- **PTS**: Total points scored per game.
- **Season**: Season identifier (e.g., 1997–1998).
- **MVP**: Binary indicator for the Most Valuable Player award (one player per season).
- **Height**, **Weight**: Physical characteristics of the player (in cm and kg).
- **Net Rating**: Team point differential per 100 possessions while the player is on the court.
- **ORB%**, **DRB%**: Percentage of available offensive and defensive rebounds grabbed by the player while on the floor.
- **USG%**: Usage rate – the percentage of team offensive possessions used by the player (through shots or turnovers).
- **TS%**: True shooting percentage – a measure of shooting efficiency including free throws and 3-point shots.

- **AST%**: Assist rate – the percentage of teammate field goals assisted by the player while on the court.

Data sources:

- Seasons 1997–2022: <https://data.world/etocco/nba-player-stats>
- 2022–2023 season: https://www.basketball-reference.com/leagues/NBA_2023_per_game.html
- Player height and weight: <https://www.kaggle.com/datasets/justinas/nba-players-data>

3 Classification By Roles

Given the aforementioned roles, we performed three separate classifications of NBA players using the EDDA (Eigenvalue Decomposition Discriminant Analysis) method. The first classification included all available seasons from 1997 to 2023. The second focused on the earliest years in the dataset (1997–2002), while the third covered the most recent seasons (2018–2023).

For each of these timeframes, we identified the best-fitting model and the corresponding Misclassification Error Rate (MER) through appropriate statistical analyses. When considering all seasons, we obtained an MER of approximately 34% and identified the best model as a Gaussian mixture of type `pk_L_Bk` (EVI). For the early period (1997–2002), the MER decreased to around 24%, with the best model being of type `pk_Lk_D_Ak_D` (VVE). In the most recent seasons (2018–2023), the MER increased to approximately 40%, with the same best-fitting model type `pk_Lk_D_Ak_D` (VVE).

Assuming a mixture of mixtures, we also applied classification using the MDA (Mixture Discriminant Analysis) method. However, this approach did not lead to substantial improvements in terms of Misclassification Error Rate.

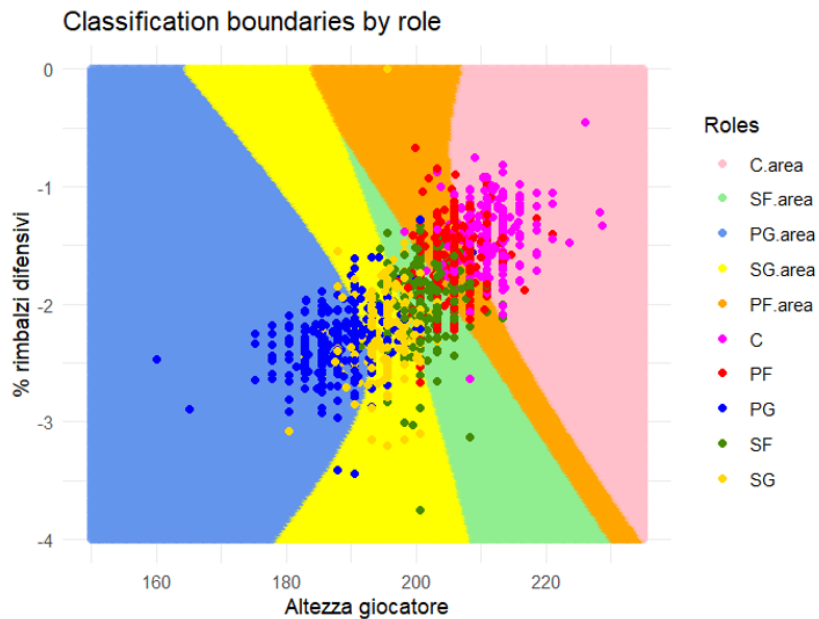


Figure 1: Classification boundaries by role

Table 1: Average values by role classification (All Seasons)

	PG	SG	SF	PF	C
Height	189	195	202	205	211
X3PA	2.78	3.26	2.63	1.58	0.485
X2PA	5.37	5.31	4.97	6.04	6.15
X3P.	0.344	0.361	0.357	0.398	0.466
AST	3.94	2.06	1.49	1.36	1.09
DRB.	0.094	0.103	0.125	0.173	0.196
BLK	0.192	0.246	0.358	0.557	1.02
ORB	0.510	0.590	0.871	1.56	1.99

4 Interpretation of results

From the results obtained, we observe that, on average, the classification of player roles is approximately 10% more accurate in the 1997–2002 period compared to the 2018–2023 period. This suggests that 20 to 25 years ago, there was a clearer distinction between roles, both in terms of physical characteristics and on-court organization. In recent years, the American basketball league has become increasingly “roleless,” with players showing more homogeneous positioning and playing styles. This trend is reflected in the statistics, as the classifier trained on the most recent seasons performs significantly worse. Furthermore, the average vectors for each role indicate diminishing differences among role-based groups, further supporting the hypothesis of a less rigid role structure in modern basketball.

Table 2: First 5 seasons

	PG	SG	SF	PF	C
<i>Height</i>	187	197	203	206	212
<i>X3PA</i>	1.86	2.52	1.82	0.456	0.146
<i>X2PA</i>	6.51	6.97	7.17	7.10	6.57
<i>X3P.</i>	0.363	0.368	0.381	0.472	0.469
<i>AST</i>	4.30	2.43	1.78	1.20	1.00
<i>DRB.</i>	0.089	0.099	0.129	0.182	0.193
<i>BLK</i>	0.126	0.282	0.411	0.602	1.12
<i>ORB</i>	0.546	0.751	1.22	1.96	2.01

Table 3: Last 5 seasons

	PG	SG	SF	PF	C
<i>Height</i>	190	195	201	205	210
<i>X3PA</i>	3.60	3.86	3.60	3.06	1.32
<i>X2PA</i>	5.41	4.93	4.65	4.94	5.95
<i>X3P.</i>	0.351	0.349	0.345	0.330	0.402
<i>AST</i>	4.12	2.42	1.83	1.67	1.59
<i>DRB.</i>	0.097	0.102	0.129	0.154	0.201
<i>BLK</i>	0.271	0.280	0.399	0.551	0.961
<i>ORB</i>	0.524	0.601	0.827	1.23	2.07

From the tables, we can observe significant changes in how players are used on the court

and in their characteristics. The most striking difference is the number of three-point attempts, which has doubled for guards, increased fivefold for power forwards, and tenfold for centers. This shift is due to the fact that positions once considered purely physical and mostly defensive now display great shooting touch and three-point ability, while still maintaining strong rebounding and defensive skills thanks to their size.

On the opposite end, two-point attempts have declined in recent years for all positions except centers. This trend can be attributed to the "Stephen Curry effect." Since his NBA debut in 2009, the Golden State Warriors star—widely regarded as the greatest shooter in basketball history—has revolutionized the game with his long-range shooting. His style has influenced teams to prioritize three-point shots over mid-range or inside scoring.

This philosophy has become foundational in NBA team strategies, especially among coaches who adopt a data-driven approach to the game. They argue that taking a higher volume of three-point shots, even at lower shooting percentages, is more efficient than focusing on two-point shots with higher success rates. The coach who pushed this theory to its limits was Mike D’Antoni, a former player for Olimpia Milano, who during the 2018–2019 season with the Houston Rockets showcased this new approach to the world.

As shown in the figure [2], the column for the Houston Rockets (HOU) stands out with a significantly higher number of three-point attempts compared to other teams.

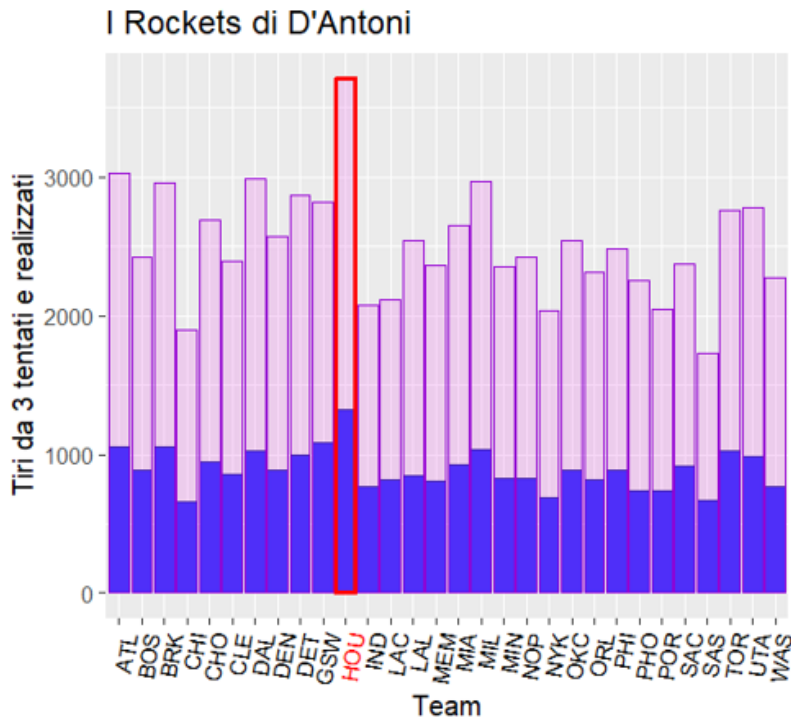


Figure 2

5 Three roles cluster analysis

“There are not even really positions. It’s like you have your ball handler, you have your off-ball guys, you have your big.”

This quote by **J.J. Redick**, former NBA player and current analyst, inspired us to explore his theory using data from the last four NBA seasons (2019–2023). By applying a cluster analysis and selecting the model based on the *Integrated Completed Likelihood* (ICL) criterion, we identified the best-fitting model as a “VVV” Gaussian mixture with 3 clusters.

This result appears to align well with Redick’s theory. By examining the average values of the key variables within each cluster, we can clearly associate them with the roles he described:

- **Ball handler:** Typically shorter and smaller in size, this player controls the offense and distributes the ball. Consequently, they tend to have a high number of assists and a strong shooting efficiency, as smaller players often excel in shooting.
- **Off-ball guys:** These players support the ball handler and rely on movement and screens to find open shots. As a result, they generally record high shooting percentages, since their attempts are often uncontested and of higher quality.
- **Big:** As the name suggests, this role is associated with taller and heavier players. Their physical presence enables them to set effective screens and dominate in rebounding situations.

	Ball Handler	Off-Ball	Big
USG.	0.212	0.158	0.182
AST	3.99	1.33	2.53
DRB	3.27	2.78	4.80
X3P.	34.9%	35.5%	38%
BLK	0.352	0.408	0.917
Weight	92	99.3	105
Height	194	200	204

Table 4: Average statistics by cluster (2019–2023)

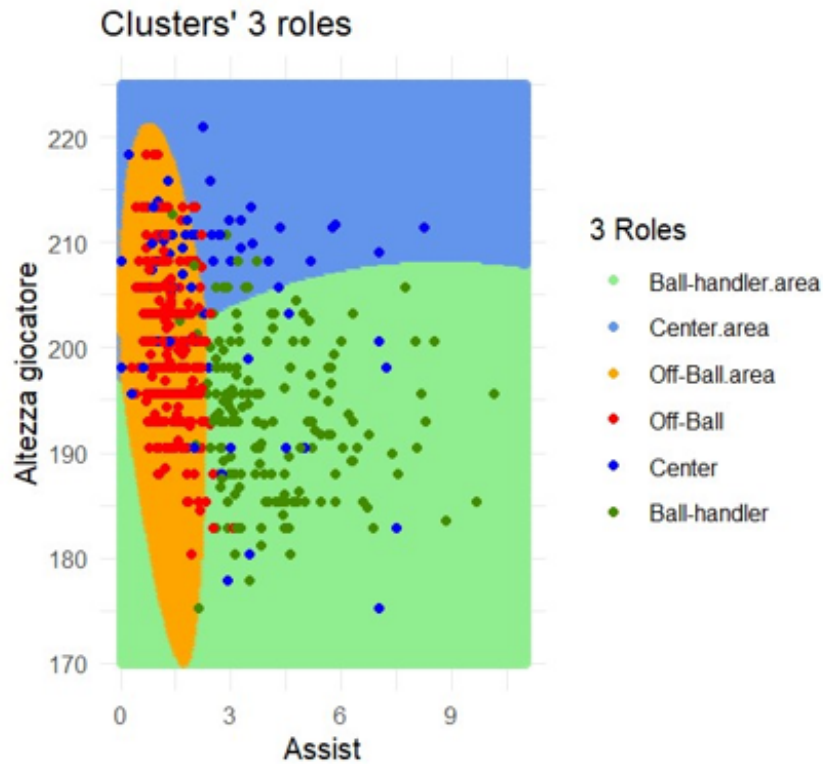


Figure 3

By observing the values obtained from the clustering of the three roles, we can clearly identify the presence of a ball handler, reflected by a high number of assists, a greater usage rate, and a shorter average height compared to the other two groups.

The off-ball player's profile is also accurately captured, as indicated by a lower usage rate and assist count, average height, and solid shooting percentages.

Finally, the "big" (center) stands out with a higher number of rebounds, greater height, and significantly more blocks than the other two roles.

6 Conclusions

It is well known in the American basketball community that during the 1990s, the game was more physical and centered around plays near the basket. Over time, this style has been gradually revolutionized. Our analysis confirms that modern basketball is less reliant on physicality and more focused on skill, regardless of a player's size. The game has moved players farther from the basket, demanding improved shooting abilities.

The drive to optimize on-court performance has led to increasingly "roleless" basketball—less defined by traditional positions but tactically more complex. Although grouping players into three categories might suggest a simplified structure, ball management and the creation of efficient scoring opportunities now require more precise tactics, movement, and spacing.