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# Improving Game Strategies with Data Analytics:

## The Case of Euroleague Professional Basketball

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# The Sports Business

- Estimated market value of spectator sports in the United States is in the range of hundreds of billions of dollars.
- The estimated market size of spectator sports in the United States is double that of the automotive industry and is easily one of the top-10 business markets globally [1].

Estimated Size of The Entire Sports Industry, U.S.	US \$ 496 Billion	2016
Estimated Size of The Global Sports Industry	US \$ 1.3 Trillion	2016
Annual Company Spending for Sports Advertising, U.S.	US \$ 36.6 Billion	2016

# Decision Making in Sports Business

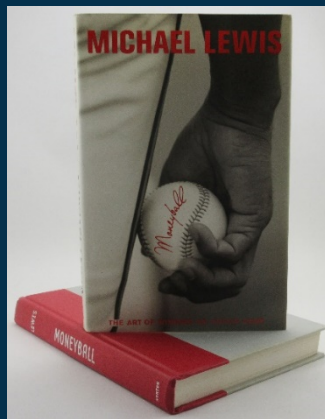
- Decision-making is a fundamental element of any sport, especially open, fast, dynamic team sports such as volleyball, football, soccer, rugby, and basketball.
- At the elite level, coaches and athletes continuously face temporally constrained and complex decisions [2].
- In order to facilitate decision making prior to and during sport events, teams need to collect and analyze data.

# Sports Analytics

- **Sports analytics** is the process of using data and statistics to help coaches, general managers and scouts make more informed decisions, in order to provide competitive advantage to teams or individuals [3].
- First applications of sports analytics were in Major League Baseball (MLB) at the beginning of the 1900's.

## The Term "Sports Analytics"

- The term "Sports Analytics" was popularized in mainstream sports culture following the release of the 2011 movie, Moneyball.



*Moneyball: The Art of Winning an Unfair Game* is a book by Michael Lewis, published in 2003

# Sports Analytics Categories [4]

- On-Field Analytics
  - Improving the on-field performance of teams and players
  - Game tactics
  - Player fitness
- Off-Field Analytics
  - Help sport organizations surface patterns and insights
  - Increase ticket sales
  - Improve merchandise sales
  - Improve fan engagement

## Another Form of Categorization [5]

- Team sports
- Individual sports
- League sports management
- Gambling



# Sports Analytics Phases [6]



# Tactics and Game Strategies

- **Strategy** is a plan of actions made before a game is played.
  - The 4-4-2 formation is a strategy applied in soccer games.
  - Large soccer clubs signing up children as young as three years old to their coaching academies
- **Tactics** is the activity or skill of organizing and moving the players and ball in a match.
  - Keeping possession of the ball in the closing minutes of the game, when the team is ahead.
- **Strategy** is doing the right things, **tactics** is doing things right.

# Examples

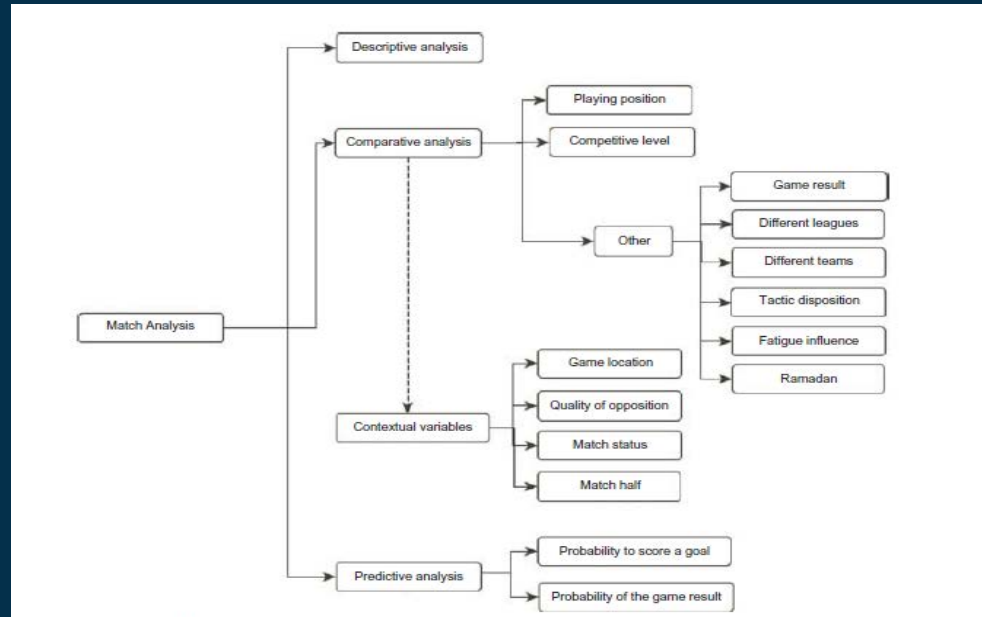
- [7] Considered under what circumstances American Football teams should lose on purpose (1973).
- [8] Used simulation to find the best batting order for a baseball team (1974).
- [9] Used probabilistic analysis to determine the best starting height for a pole vaulter (1975 ).
- [10] Weightlifting - What weights to choose? (1977)
- [11] The long jump - How close to the takeoff line to aim for? (1977)
- [12] Squash racquets - Whether to choose to play? (1978, 1988)
- [13] Darts - Which numbers to aim for? (1982)
- [14] Basketball - When to foul? (2006)

## Recent Researchers

- 2016 - Using Machine Learning to Draw Inferences from Pass Location Data in Soccer [15]
- 2017 - Using Deep Convolutional Neural Networks to Predict Goal-scoring Opportunities in Soccer [16]
- 2017 - Exploring polynomial classifier to predict match results in football championships [17]
- 2017 - Three point shooting and efficient mixed strategies: A portfolio management approach [18]
- 2018 - Evaluating NBA end-of-game decision-making [19]

# Role of Match Analysis in Improving Game Strategy [20]

- In order to reach the **winning strategy** and to better understand the constraints that promote sporting success, **match analysis** has a very important role in sports games.





# THE CASE OF EUROLEAGUE BASKETBALL

## The Euroleague Organization [21]

- Established in 2000 as a private organization managed by 11 shareholder clubs, the Euroleague® has become the second largest basketball organization in the world after the NBA.
- It boasts an average of 8351 attendances per game and 2 billion accumulated audience (2014-2015).
- Due to the Euroleague's® financial improvements since its foundation, it has become the most important indoor team sports organization in Europe.

# The Euroleague Organization

- With a total population of 743 million people (2015), EU countries provide fundamentally high-educated players to the Euroleague.
- US also provides players to Euroleague. 33% of the players for the past 10 years were from the US.

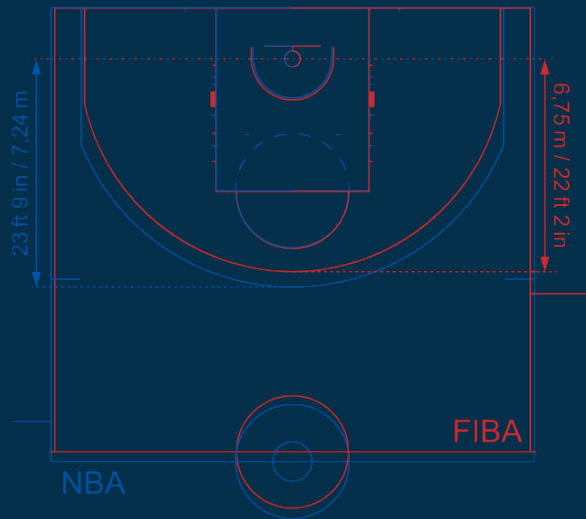


■ Euroleague Participant Countries



# The Euroleague Organization

- FIBA (Fédération Internationale de Basketball) rules are applied in the Euroleague organization.
- The court size and inner-dimensions are slightly different from the NBA.



- The most important difference between a Euroleague court and an NBA court is three point line vertical distance. While the Euroleague has 6.75 meters, the NBA has 7.24 meters vertical distance.

## The Euroleague Organization [22]

- Regular season is played between October and April.
- Round-robin format, for a total of 30 games by each of the 16 teams. 8 teams advance to play-offs and play best-of-five series to advance to final-four. Final-four is played by single-elimination matchups.
- Each game consists of four 10-minute periods. In case of a tie 5 minutes of overtime is played. Overtime periods are played until one team is ahead at the end of the overtime.
- Shot clock is the same as the NBA which is 24 seconds.

# Research Question

" How to improve shooting efficiency in professional basketball with the help of analytics applications "

# Research Data

## Data Source [23]

- Euroleague website
- Data for the past 10 years
- Approximately 2000 games and 230,000 shot attempts
- Spatio-temporal, player and shot type variables
- Free throws, dunks and layups were excluded due to their distinct nature

# Research Methodology

## Variables

Player Related	Shot Related	Game Related	Time Related	Performance Related
Position	Angle	Game Phase	Minute	Season Performance
Age	Distance	City	Quarter	Month Performance
Height	Radial Zone	Score Differance	Game Month	Game Performance
Nationality	Shot Type	Home Team	Season	Quarter Performance
Team		Away Team		

# Descriptive Analysis

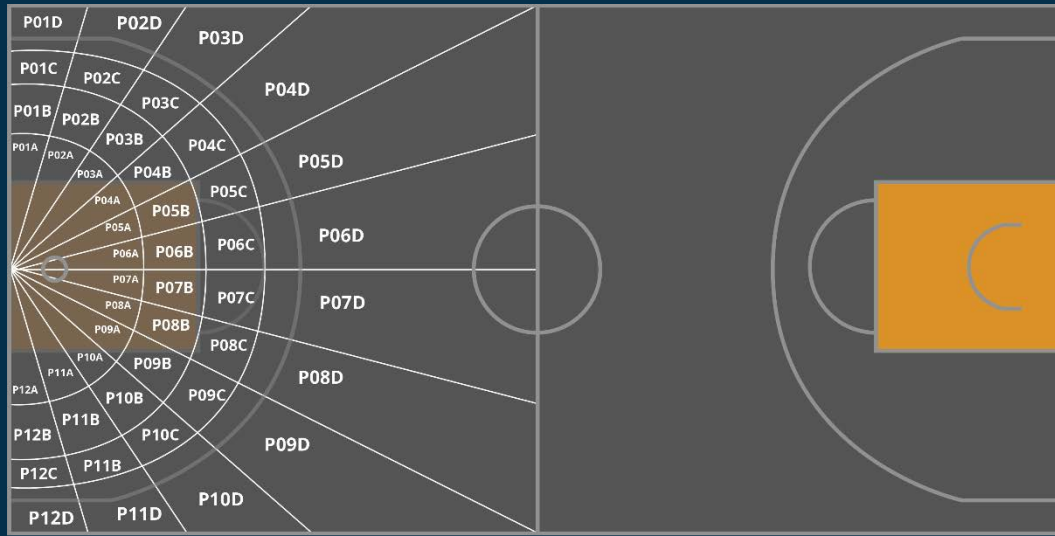
## Game Evolution – Total Shot Attempts vs. Success Rate Per Minute



# Descriptive Analysis

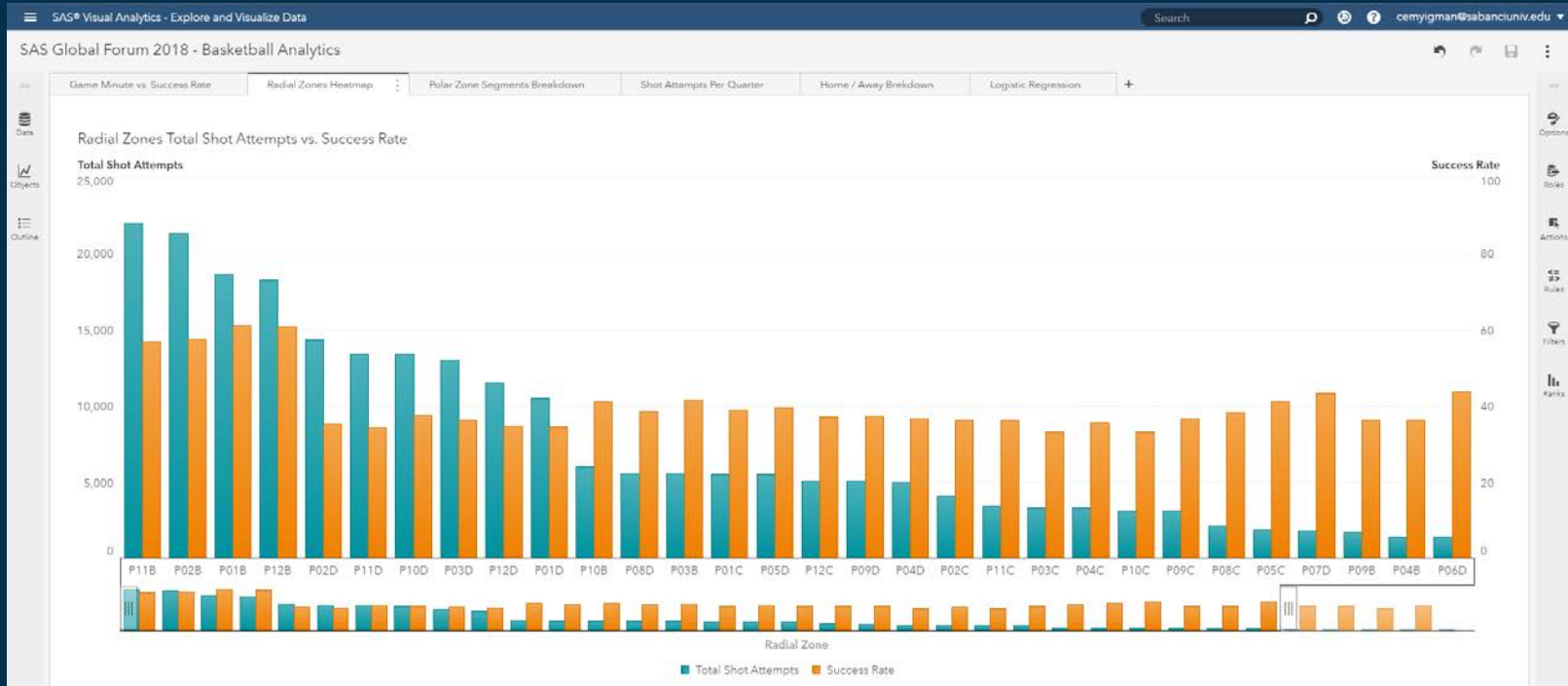
## Radial Zones for Location Analysis

- The court is divided into 12 slices of 15 degrees each
- Each slice is divided into 4 segments



# Descriptive Analysis

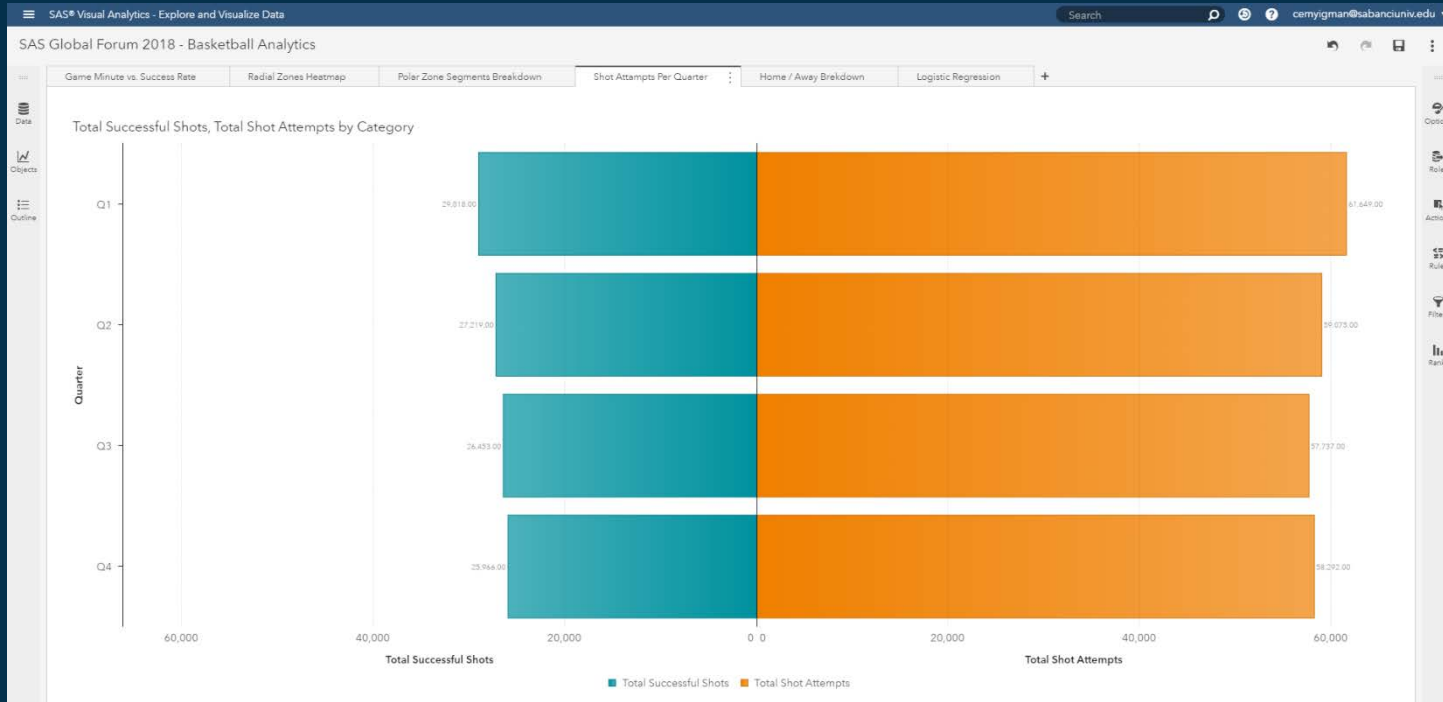
## Radial Zones - Total Successful Shots vs. Shot Success Rate





# Descriptive Analysis

## Game Quarters - Total Shot Attempts vs. Success Rate



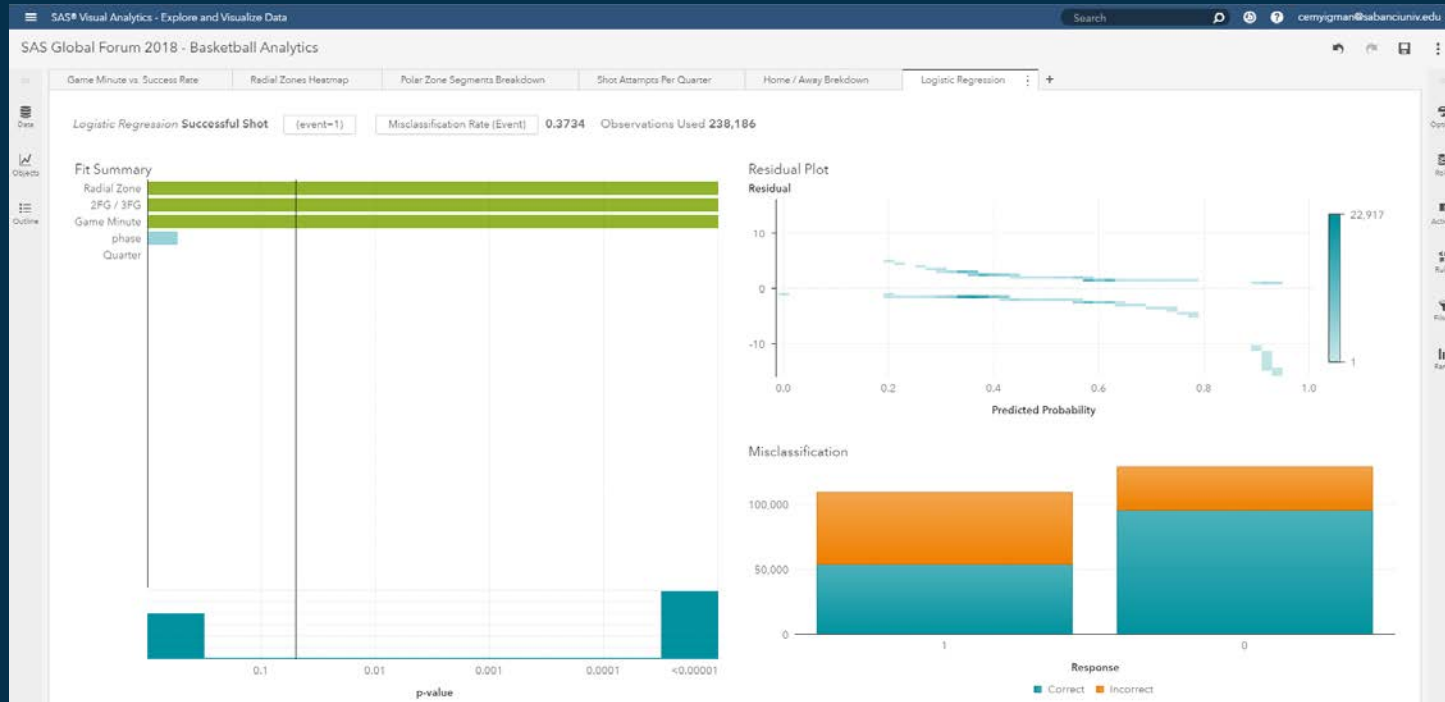
# Predictive Analysis

## Logistic Regression

- SAS Visual Analytics Logistic Regression was run with 5 variables.
- Misclassification rate in train data for predicting a successful shot was 37%.
- Performance index variables such as season rating, month rating, game rating and quarter rating of each individual player will be added to the variable set to create a more powerful model.

# Predictive Analysis

## Logistic Regression



# Preliminary Study Outcomes

- On-Field Analytics
  - Using the predictive model built with the significant variables, we are going to try to find the best possible shooter on the field with higher chances of a successful shot
  - Preliminary predictive model with predictor variables below gave 35 % misclassification rate with basic logistic regression
  - Radial Zone
  - Minute
  - Action (2FG or 3FG)
  - Game Phase (Regular Season, Playoff, Final Four)

# Future Work

- Improving misclassification rate with other models such as random forest
- Simulating certain scenarios to find the best possible player on the field with given attributes
- Searching for improvements for the significant variables
- Searching for non-linear relationships
- Trying fixed-effects models with player and team variables

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# Presenter Bio

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Raha is associate professor of Operations Management and the co-director of Masters in Business Analytics at Sabancı School of Management. Prior to this role, she has held the positions of Associate Professor of Operations Research and founding director of Masters in Analytics at Universidad de Los Andes in Bogota, Colombia, and Senior Industrial Engineer at Intel Corporation in Arizona, USA. She has received her PhD in Industrial Engineering and Operations Research from North Carolina State University. Her research is focused on stochastic modeling and data-driven decision making with applications in healthcare, logistics, revenue management and reliability.

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