NBA Games Data

Predicting the Characteristics of Basketball Winners

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ABSTRACT

Our project hopes to answer the simple question: what is the best way to win basketball games in the NBA? This is not a question of what playstyle is most aesthetically appealing to athletes and fans, as that is entirely subjective. In competitive sports, the best way to play is the strategy that wins you the most games, not the playstyle that you personally prefer. Professional sports is the closest we may ever get to a true meritocracy, so we intend to discover the objectively best way to play basketball according to wins and losses.

CCS CONCEPTS

• Data Mining
• Machine Learning
• Applied Computer Science

KEYWORDS

Basketball, NBA, Statistical Analysis

ACM Reference format:

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1 Problem Statement/Motivation

All NBA teams face the same problem: how do we win more games? In order to answer this question, we want to build a statistical model that can predict win rates in the NBA with the greatest accuracy possible. Our group intends to accomplish this by utilizing data mining tools such as market basket analysis, Apriori, and Bayesian classification. By searching for the stats that correlate highest with win rates, it is our hope that we will find the strongest predictors of winning basketball.

Throughout the NBA's history, there have existed platitudes like "defense wins championships" and "you can't live and die by the three." These beliefs are based on subjective opinions, not verifiable research. Anecdotal evidence is not statistical data, so we intend to either prove or debunk some of the NBA's most commonly held wisdom.

We hope to make novel discoveries within the NBA's team and player statistics. They say that the best predictor of future behavior is past behavior. To predict who will win the most games in the future, we need to discern which teams and players have won the most games in the past. This information will also help us answer the question of who are the most dominant players and teams?

Everyone has a different argument for who is the Greatest of All Time, but our group hopes to answer that question using empirical data rather than personal opinion.

2 Literature Survey

The NBA itself has conducted extensive research on this subject. The league maintains a vast database of game statistics that can be accessed on their official website: https://www.nba.com/stats [1]

The following is an article citing how data analytics changed the way basketball is played: https://d3.harvard.edu/platform-digit/submission/how-data-analytics-is-revolutionizing-the-nba/ [2] The article talks about how players like Stephen Curry use shooting charts to determine the best locations on the court to take shots from. Curry and the Golden State Warriors are major contributors to the NBA's three point revolution. The article also talks about how teams use fatigue data to predict and prevent player injury.

The next article is about the importance of injury prediction in the National Basketball Association: https://sportsanalytics.berkeley.edu/articles/is-injury-prediction-the-next-moneyball.html [3]
A great deal of games are lost every year due to injuries, so teams invest heavily in preventing histories and maintaining player health. Whether in winning championships or improving athlete safety, the NBA is constantly utilizing advanced statistical analytics to make the game better.

3 Proposed Work

Our data collection process has yielded a dataset that contains data on basketball games taking place between 2004 to 2020. The dataset is split up into multiple csv files, so we will need to integrate all of it into a single data frame. The data cleaning process will require us to remove irrelevant data, such as the date on which games were played. We will also not consider player statistics for athletes who participated in an inconsequential amount of games, so as to avoid outliers. There are several benchwarmers throughout the NBA who could become outliers for stats like net plus/minus. We will not consider these players in our data analysis, as there's no reason to inflate the relevance of an individual who hardly played in any games.

We intend to perform exploratory data analysis to calculate correlations between win percentage and every statistical category in our datasets. We will generate graphs comparing stats for players and teams side by side. Our group shall also produce correlation heat maps to demonstrate the impact of each unique stat on win rate.

Our intention is to perform market basket analysis to discover which sets of players competed in the most games together. This information will help us determine which teammates worked best together. It is also a commonly held belief within the NBA that roster consistency is one of the keys to winning basketball. We hope to discover if this is true, or if it's possible to win consistently with high roster turnover.

We plan to use machine learning methods, like Bayesian classification and K nearest neighbor, to create a predictive model of wins in the NBA. We will need to control for both overfitting and underfitting in order to optimize the performance of our model.

Our proposed work is different from the research cited in our literature survey, because it will not be specialized to any one team or player. When NBA franchises study analytical data, they are doing so with the sole purpose of improving their own team. They are searching for information that may help them make player trades or sign

free agents. The teams look for knowledge that can help them change their coaching strategies. Athletes use their own player stats to prove their credentials when negotiating their contracts. Sports media considers statistical data when voting on awards such as Most Valuable Player.

Our project will be different because we seek to discover basketball truths without bias. It doesn't matter to us who the best player is or who's the best team. We simply wish to learn the answer to those questions and the reasons why the winning teams and players are so successful. With this knowledge, our hope is to construct a statistical model that will predict the future success of NBA teams with the greatest possible accuracy.

4 Data Set

Our data set is obtained from Kaggle, here: https://www.kaggle.com/datasets/nathanlauga/nba-games?resource=download [4]
The data set contains details on games played between 2004 and 2020. The data includes hundreds of thousands of rows detailing player stats posted in every game. There is also data on the winning team of each game played during the 2004-2020 time frame. This data is organized by home and away teams, so we can also track the home and road records of every team. One particular point of interest will be the home record of the Denver Nuggets due to the high altitude that they play at. All data has been downloaded and is currently saved on a private computer.

5 Evaluation Methods

The results of our data mining project will be evaluated based on the predictive accuracy of our machine learning model. This can be measured using training and test datasets to guard against both overfitting and underfitting. We can also evaluate our statistical model by using it to predict seasons outside of the 2004-2020 timeline. In particular, the full 2021-2022 NBA season has been played since the publication of the original data set. This recent season can provide an evaluation of the predictive capabilities of our data model.

6 Tools

- Jupyter Notebook
- Python libraries (e.g. pandas, numpy)
- Structured Query Language
- Github

7 Milestones

We plan to complete the exploratory data analysis by the time of our next project progress report, as well as to have performed market basket analysis using the Apriori algorithm. After this, we intend to implement more machine learning techniques, like Bayesian classification, to build our predictive data model.

7.1 Milestones Completed

We have accomplished our intended goal of exploratory data analysis. Our group plotted graphs displaying the win/loss records of every team and their point differential. We also created bar graphs comparing the plus/minus of top players versus their individual points scored.

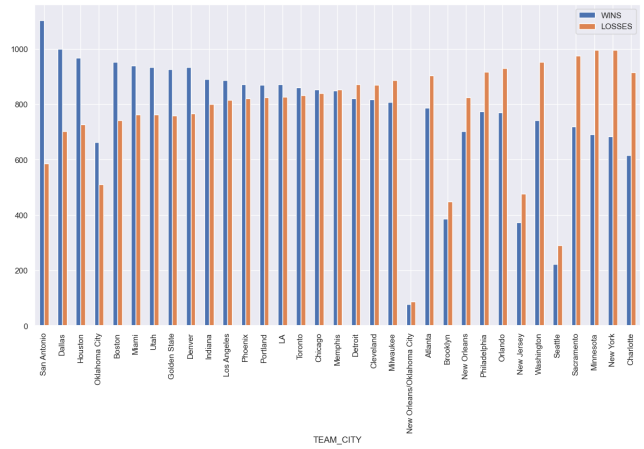
Our team has performed Apriori market basket analysis according to plan. We learned that LeBron James has played in more NBA games than any other active player by a wide margin. Subsets of teammates who played many games together consisted mostly of members of the San Antonio Spurs.

7.2 Milestones Todo

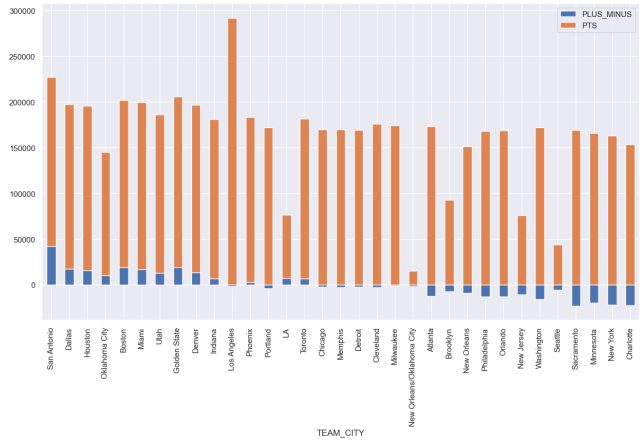
Our group still plans on integrating the player data so that we can track wins and losses by individual players as well as by team. We are still planning to implement a machine learning model that can predict the future performances of teams and players. We hope to evaluate the performance of our model by testing it on recent NBA seasons that were not included in the original database.

8 Results So Far

Below is a graph of every team in the NBA charting their total wins and losses over the recorded time period.



The stacked bar graph below shows every team's total points scored in orange versus their net point differential in orange.



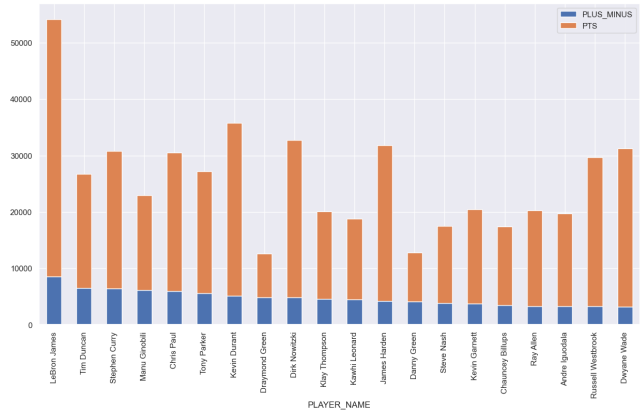
Both of the graphs shown above are sorted by winning percentage, so it's obvious why the teams on the left have more wins and the teams on the right recorded more losses. The second graph clearly shows how net point differential is a far superior predictor of win rates compared to gross points scored.

The Los Angeles Lakers are an outlier that proves the old adage that "Defense wins championships." The Lakers scored the most points out of any team in the NBA by quite a wide margin. Despite the productivity of their offense, their team's net plus/minus is still negative because their defense was so porous that opposing teams still managed to outscore them on average.

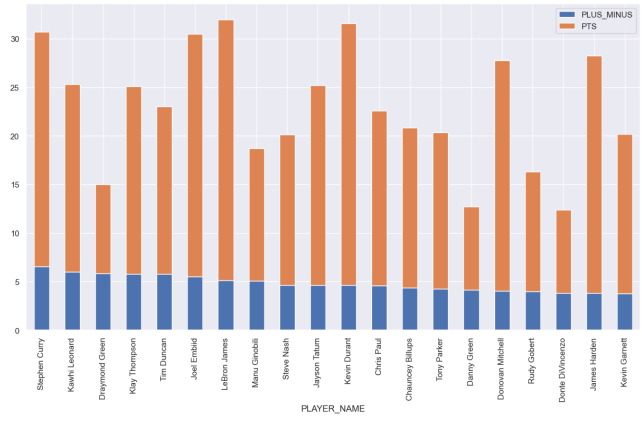
Another strange outlier is the New Orleans/Oklahoma City team. This franchise used to be called the New Orleans Hornets before relocating and becoming the Oklahoma City Thunder. The city of New Orleans got a new team called the Pelicans. Once the team name Hornets was unused, the Charlotte Bobcats rebranded themselves the Charlotte Hornets. Due to the convoluted way in which franchise names changed hands between these three

teams, the data tracking those teams during the transition became very niche.

The plot below lists the top 20 players according to their total plus/minus. Each player's overall plus/minus is depicted in blue and their total points scored is shown in orange.



The following graph shows the top 20 ranking listed in order of average plus/minus and points. Mean plus/minus is shown in blue while points scored per game is displayed in orange.

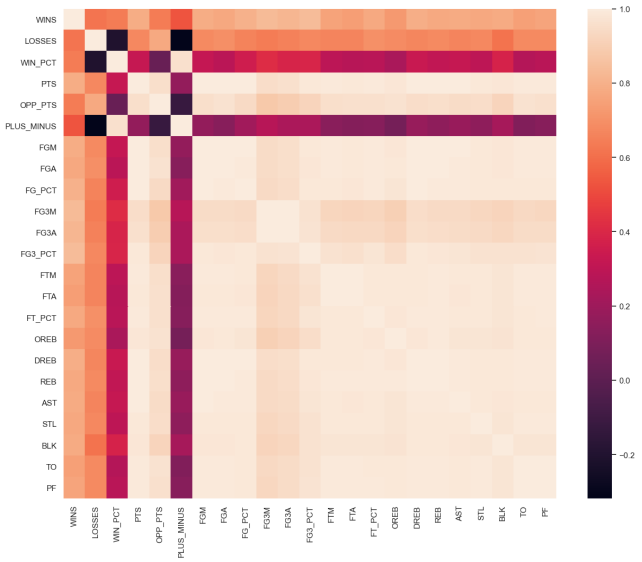


The average plus/minus rankings required data cleaning in order to obtain an accurate listing. When we attempted to generate the list involving every player in the NBA, we found that the top players were random players who no one had ever heard of. It was obvious that the best players in the NBA couldn't be complete unknowns, so we quickly realized our error. By tracking games played according to player minutes, our group found that the highest plus/minus averages belonged to athletes who played in very few games. Due to their low amount of games played, the plus/minus per game average became artificially inflated. To fix this problem, we calculated the average number of games played by athletes across the entire league. Any players whose total games played came below the threshold of league average were expunged by our data cleaning process.

Many of the same players appear in both top 20 lists. One notable difference in the two rankings is how high the Golden State Warriors ranked in the average plus/minus metric. Steph Curry, Draymond Green, and Klay Thompson occupy 3 of the top 4 spots in the rankings. All three of these athletes are also in the total plus/minus rankings, but Curry is the only one within the top 7 of that chart.

The total plus/minus rankings were dominated by the San Antonio Spurs. Their Big 3 of Tim Duncan, Manu Ginobili, and Tony Parker are all within the top 6. Duncan ranked second only to LeBron James who had the highest net plus/minus and the most points scored of anyone in the entire league. LeBron represents an outlier in the first graph because his total overall stats overwhelm everyone else's. But when sorted by average plus/minus and points score per game, LeBron's dominance is brought closer to Earth as his statistics become comparable to those of players like Steph Curry and Kevin Durant.

Below is a heatmap showing the correlation between winning percentage versus every over stat in the database.



The top 3 predictors are rather obvious: winning percentage itself, team plus/minus, and win total. The next three top correlated stats are particularly interesting because they're all 3 point shooting statistics. Three points made, 3 point percentage, and 3 pointers attempted are some of the most strongly positive correlations with win rates. This correlation matrix provides statistical evidence against the old fashioned notion that "Jump shooting teams can't win championships."

The results of our Apriori market basket analysis showed that LeBron James is the individual who appeared in the most NBA games by far with a support of 6.63%. By comparison, the next player on the list was Andre Iguodala with a support of 5.76%. LeBron's support is almost a full percentage point higher than the second ranked athlete, demonstrating just how long and prolific his career has truly been.

When looking at sets of teammates who played together in a great number of games, LeBron James ironically doesn't appear at all on the list. He has won 4 championships with 3 different teams, which means he hasn't shared the court with any one particular teammate for long. LeBron's former teammate, Dwyane Wade, played far more games with Udonis Haslem than he ever did with James. LeBron James is widely considered the greatest player of our era due to his ability to win championships at the highest level regardless of who his teammates are.

Our market basket analysis showed that the Big 3 of the San Antonio Spurs played by far the most games together as teammates. In both 2 player and 3 player sets, different combinations of Duncan, Ginobili, and Parker yielded the highest support and confidence numbers. The longevity of the Spurs dynasty provides evidence for the belief that roster stability can produce sustainable success for a team. San Antonio won 5 championships during the Tim Duncan era. They also won an astonishing 65% of the games they played during the timeline of our dataset.

ACKNOWLEDGMENTS

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