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# Predicting NBA MVP With Historical Data

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Sid Lamsal

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## 1 Summary of the Data Set

The National Basketball Association (NBA) Most Valuable Player (MVP) award is an individual-player award given to the most valuable player in each NBA season. The award is voted on by sportswriters and broadcasters throughout the US and Canada who follow the NBA regularly [3]. The term “value” is fairly ambiguous, which means that the MVP award is not always very straight forward since the word “value” may have a different meaning for each voter. This report attempts to take a statistical approach to predicting the MVP based on past winners and candidates. The report finds that the MVP is difficult to predict due to outside factors which are not accounted for in the stats.

The data set for this project contains the statistics for NBA MPV award candidates from 1980 to 2021 (considered to be the “modern age” of basketball). The unaltered data set contains 679 sample units and 45 variables. During the cleaning of the data set, a binary variable was added which contains a value of 1 if the player won MVP, and a 0 if they did not. The number of MVP votes won was standardized by multiplying the players percentage of the votes by 1000 into a new variable called scaledPtsWon. This was done because the number of available MVP votes changed over the years. Repeated rows and columns, as well as columns of low importance were removed, and the data set was given row names by combining the name of the candidate and the year. Lastly, a sample data set containing only the MVPs was created for comparison purposes during visualization. After alterations were made, the main data set was 678 sample units and 36 variables containing basic stats like points and rebounds as well as advanced metrics.

## 1.1 Summary of Variables

Table 1: Summary of Variables

Statistic	Meaning
All variables represent values in a specific season	
Won MVP	If the player won MVP (1 = yes, 0 = no)
Age	Age of the Player
Scaled MVP Votes Received	How many votes for MVP did they received (scaled)
Games Played	How many games a player played (82 possible)
Minutes Played Per Game	How many minutes a player played per game. A regular game (no overtime) is 48 minutes long with 12 minutes quarters.
Points Per Game	How many points the player scored per game
Total Rebounds Per Game	How many total rebounds (securing the ball after a missed shot) the player secured per game
Assists Per Game	How many assists (passing to a player who then scores) the player had per game
Steals Per Game	How many steals (taking the ball from the opponent) the player had per game
Blocks Per Game	How many blocks (rejecting the ball when an opposing player attempts to score) the player had per games
Field Goal Percentage	Percentage of shots made per game
Three Point Percentage	Percentage of three pointers made per game
Free Throw Percentage	Percentage of free throws made
Win Shares	An estimate of the number of wins contributed by a player[1]
Win Shares Per 48 Minutes	An estimate of the number of wins contributed by the player per 48 minutes [1]
Wins	Number of wins in the entire season (max 82)
Win-Loss Percentage	Percentage of games won
Seed	Ranking among other teams in the same conference
Player Efficiency Rating (PER)	A per-minute rating of a player's performance taking into account the positive and negative statistics[1]

True Shooting Percentage	A measure of shooting efficiency that considers field goals, 3 point shots, and free throws[1]
Three Point Attempt Rate	What percentage of the player's shots were 3 point attempts[1]
Free Throw Attempt Rate	Number of free throws compared to field goals[1]
Offensive Rebound Percentage	Percentage of available offensive rebounds secured while the player was playing[1]
Defensive Rebound Percentage	Percentage of available defensive rebounds secured while the player was playing[1]
Total Rebound Percentage	Percentage of available rebounds secured by the player while they were playing[1]
Assist Percentage	Percentage of teammate field goals a player assisted on while they were playing[1]
Steal Percentage	Percentage of opponent possessions that end with a steal by the player while they are playing[1]
Block Percentage	Percentage of opponent possessions that end with a block by the player while they are playing[1]
Turnover Percentage	Percentage of turnovers per 100 possessions[1]
Usage Percentage	Percentage of team plays used by a player while they are playing[1]
Offensive Win Shares	Win shares based on defense of the player[1]
Defensive Win Shares	Win shares based on offence of the player[1]
Offensive Box Plus Minus	Points per 100 possessions that the player contributed above an average player on an average team on offensive [1]
Defensive Box Plus Minus	Points per 100 possessions that the player contributed above an average player on an average team on the defensive side of the ball[1]
Box Plus Minus (BMP)	Points per 100 possessions that the player contributed above an average player on an average team[1]
Value Over Replacement Player(VORP)	Points per 100 team possessions that a player contributed above an average player on an average team [1]

## 1.2 Basic Visualization

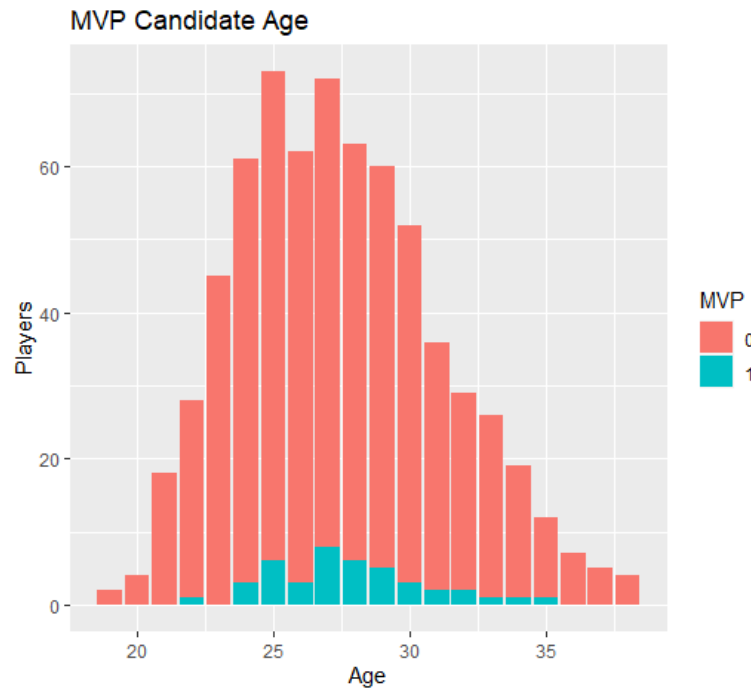


Figure 1: MVP Candidate Ages

Figure 1 shows the Age of MVP candidates and winners. Candidates seem to commonly be around 24-29 years old while winners seem to be around 25-29. This coincides with what is generally perceived to be the physical prime of NBA players. It would make sense that most MVP level seasons would occur during a player's physical prime.

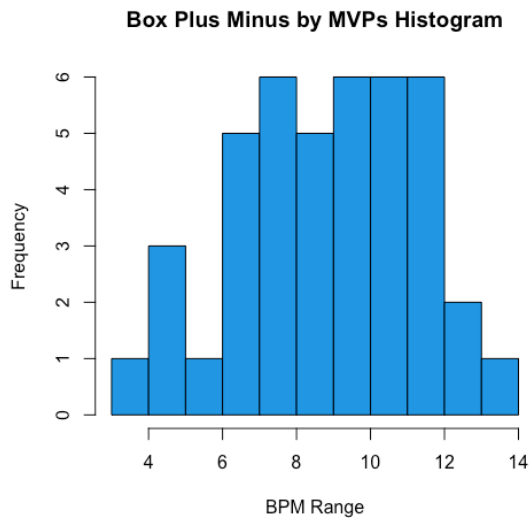


Figure 2 (Left): BPM of MVP winners

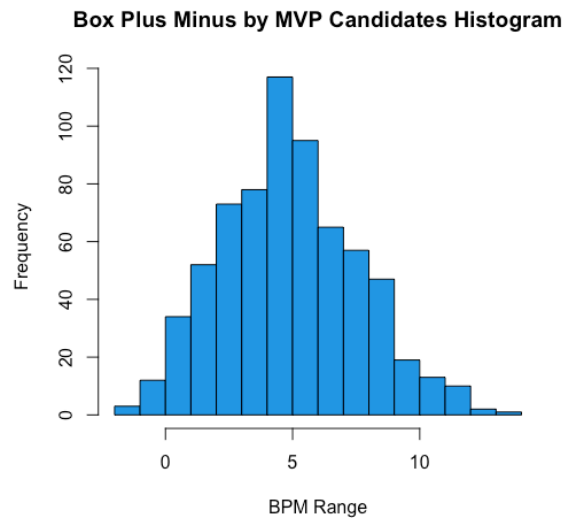


Figure 3 (Right): BPM of All Candidates

Figure 3 shows the box plus minus stat of all MVP candidates. The graphs show that MVP candidates have frequently had BPM between 4 and 6. Figure 2 shows the BPM for MVP winners. Most MVP's seem to have a BPM from 6-12.

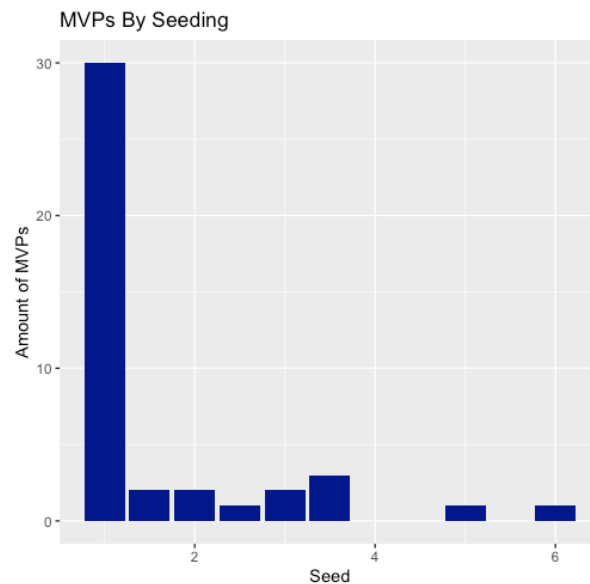


Figure 4: Team seed of MVPs

A player's team's position in their conference is considered essential when determining MVP. Figure 4 shows that an overwhelming majority of MVP's have their team at the first seed in the conference.

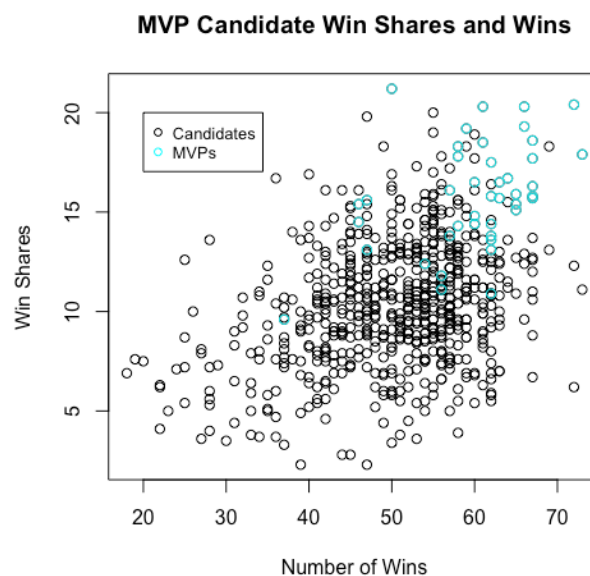


Figure 5: Wins and Win Share Scatter Plot

High seeding requires a lot of wins. Win shares try to measure how many wins the individual player contributed based on their stats. Figure 5 shows that MVPs generally have high wins and win shares. This is expected as contributing a lot of wins on a high-wins team could certainly define “value” for the MVP award.

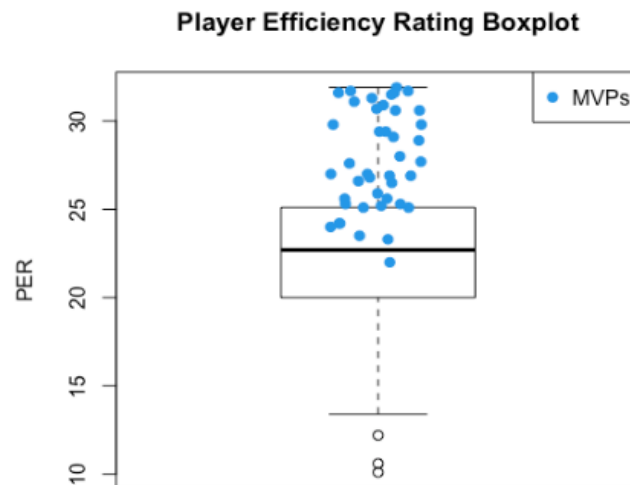


Figure 6: PER Boxplot

Player efficiency rating (PER) is a rating of a player's per-minute productivity. PER is a complicated statistic that tries to summarize a player's statistical accomplishment by assigning values to box score statistics. Figure 6 shows that most MVPs have PERs above the 3<sup>rd</sup> quartile (or greater than 75% of candidates).

## 2 Clustering

### 2.1.1 K-Means

Certain years, the MVP wins by a large margin. For example, Stephen Curry in 2016 had the first and only unanimous MVP which means every voter had him at number 1 for MVP. Other years, the MVP race is much more competitive like in 1981 when Julius Erving had 658 scaled points and Larry Bird had 613 scaled points. Another interesting situation comes about when 2 players have MVP worthy seasons, but only one person can win the award each year. As previously mentioned, Julius Erving won MVP with 658 scaled points, however, Michael Jordan in 1997 had 832 points and lost the race to Karl Malone who had 857 scaled points. There has been a total of 19 players who have accumulated more points than Julius Erving in 1981, but still did not win MVP. Clustering with K-Means will

highlight these irregularities that make statistics-only predictions very difficult. Clustering shows that it is not good enough to simply look at a single player and determine if they are deserving of MVP. The MVP is the most deserving out a select few players. With each MVP race comes different players with different relative value. For example, some years there could be 3 players deserving of MVP who all would have won had they had their respective seasons in separate years.

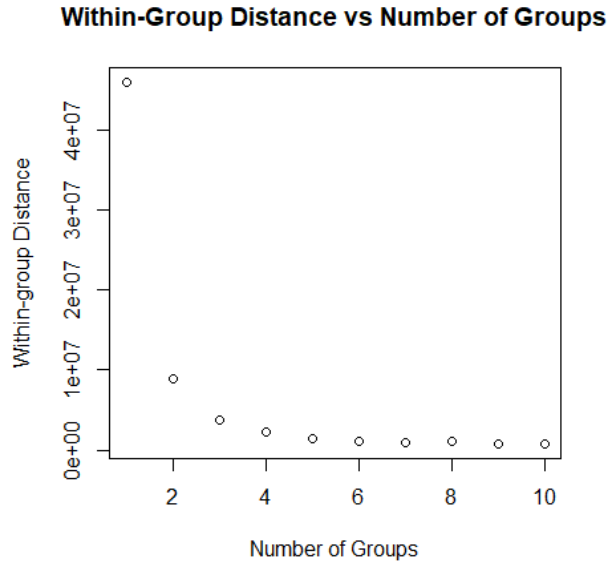


Figure 7: Within-group Distance

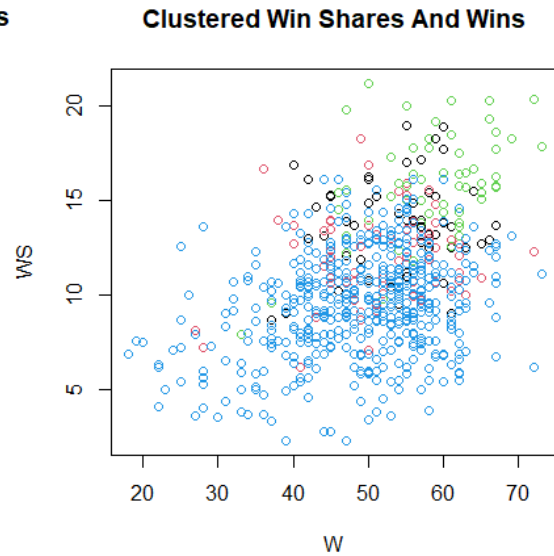


Figure 8: Clusters Scatter Plot

Figure 7 suggests that 4 may be one of the optimal number of groups to use for clustering. Looking at figure 8, the green group somewhat matches up with the MVPs in the graph of win shares and wins (figure 5) from the visualization section. This suggests that k-means properly grouped most of the MVPs in the same group which makes logical sense. However, there are also other players who may have been deserving of MVP that are included in the green group that didn't actually win the award like LeBron James in 2020. For K means, the scaled points variable was included in the distance matrix. Looking at the scaled points variable accurately groups the players who had sufficient points to be MVP caliber even if they didn't win. The average stats of these players could possibly give an idea of the type of player that could be of a similar level.

### 2.1.2 K-means Result Summary

Table 2: Cluster Summary (Shortened)

Cluster	Points Won	Wins	Win Shares	Seed	W/L	BPM	PER	VORP	# of Players
1	470.30	54.24	13.39	2.88	0.67	7.22	25.93	6.60	62
2	215.39	51.88	11.98	3.67	0.64	5.94	24.42	5.53	79
3	834.51	58.00	15.48	1.87	0.72	8.68	27.58	7.85	62
4	20.24	49.24	9.44	4.44	0.61	3.98	21.20	3.99	475

There were 62 players in group 3 which were players with high values in many statistics like scaled point won, games played, minutes played, points, rebounds, assists, just to name few (most likely the MVPs or high point candidates). Group 1 had 62 players as well. This group has second highest in most categories (most likely runners-up and low point MVPs). Group 2 had 79 players and had the second to last lowest averages in most categories. Lastly, group 4 had 475 players and they were last in most categories (had virtually no chance to win).

### 2.1.3 K-means Results Analysis

The results of k-means are fairly accurate to how the real MVP votes look. Looking at the data set, there were many players who received single digit or less than 100 scaled votes. None of these players had a legitimate chance to win. Any given year there were only a few players that received a substantial number of votes. K-means accurately shows this as group 4, which had 475 players, had an average scaled points of about 20 while the next lowest was group 2 with 79 players with an average scaled points of about 215. Furthermore, group 3 had 62 players but there have only been 42 MVP. This shows that many players that have had MVP level seasons did not get the recognition that they deserved. As previously mentioned, 19 players had a higher point total than the MVP with the lowest points.  $42+19$  would give us 61, which is 1 less than the number of players in the cluster. This perfectly highlights the issue of deserving players not winning MVP due to their competition at the time.



## 2.2.1 Hierarchical Clustering

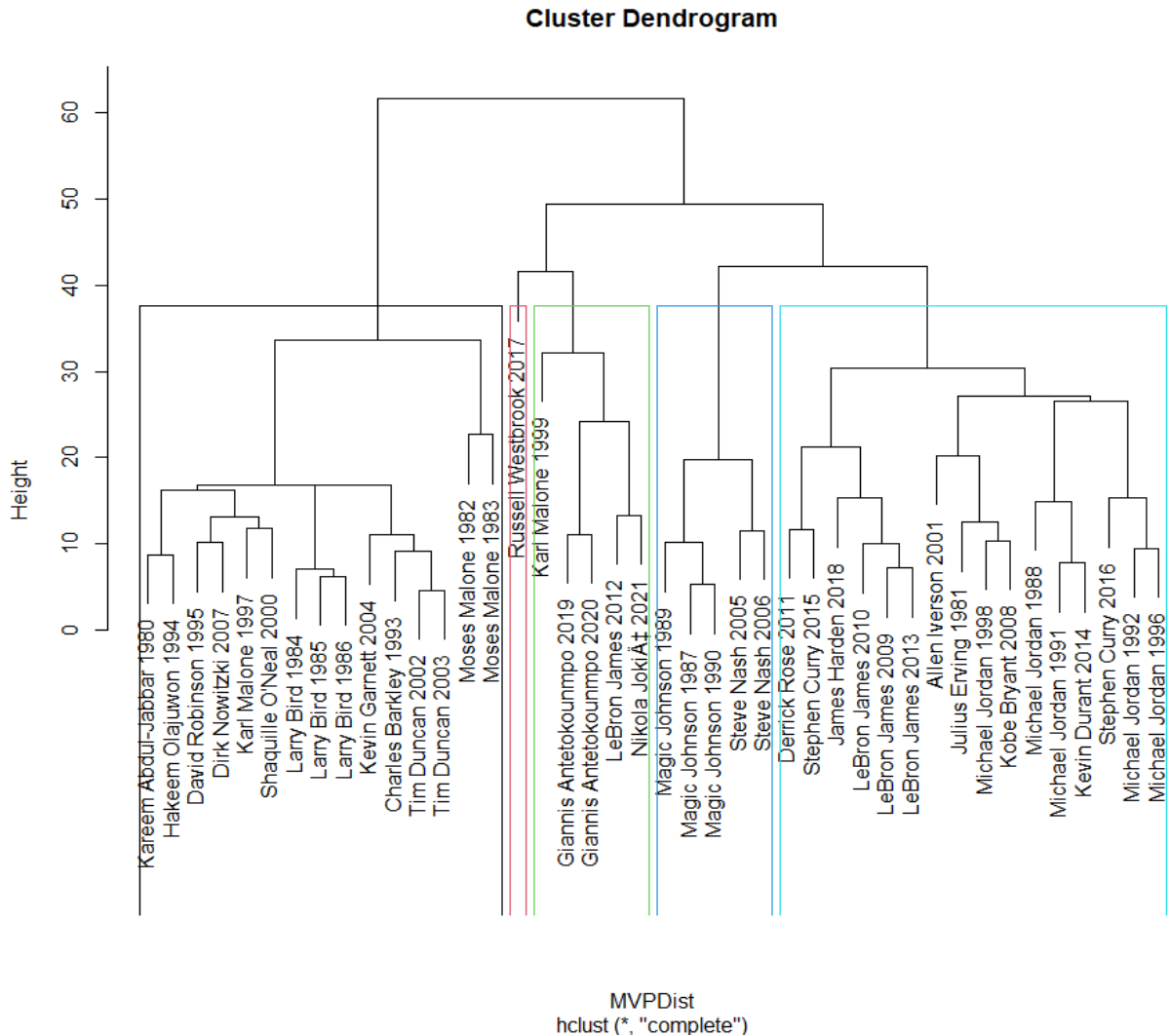


Figure 9: HC Dendrogram

K-means did a fairly good job of grouping the many candidates. There are much fewer MVP winners, therefore, hierarchical clustering (HC) provides a better visual when grouping MVP winners. Since all the winners had relatively high scaled points won, that variable was removed for HC. Removing that variable gave a better look at the similarities in how MVPs play and what type of players (playstyle) generally win MVP. The distance matrix for the HC uses Euclidean distance and the method for HC is complete.

### 2.2.2 Hierarchical Clustering Results Analysis

To someone is not very knowledgeable about the NBA, the grouping of players in the dendrogram (figure 9) seems very random. However, there is some takeaway from it. The group surrounded by black consists of mainly “big men”: term used to describe tall players that play close to the basket. The players generally have high rebounds and blocks; they also are the anchors for the defense. It is appropriate that these players are grouped together as they would be statistically similar. Furthermore, many of them are MVP winners from the 80’s, 90’s, and early 2000’s. These eras of basketball were dominated predominantly by big men (even more so in the 60’s and 70’s), so it makes sense that more big men would win MVPs during this time. A big part of why big men win MVPs is their rebounding and defense.

This presents another challenge in voting for MVP: the perception of value in the specific era. Big man play was desirable in the past, then guard play became more desirable and therefore valuable. Now the trend is shifting to players who are jack-of-all-trades. So beyond looking at a player’s statistics and their competition, predicting the MVP also requires that the player’s playstyle be considered. Since the playstyle of MVPs has changed, the stats that correlate to being MVP have also changed. For example, in the 80’s and 90’s MVP big men rebounded a lot, so rebounding could have correlated to better MVP odds. However, in the 2010s, guard play took over and guards don’t rebound a lot, so good rebounding stats might not have the correlation that they had before.

The cyan box contains many of the game’s greatest scorers like Michael Jordan, Kobe Bryant, Kevin Durant, and Steph Curry. These players are “guards” or “forwards”: guards generally handle the ball and forwards can play inside close to the basket or outside. These players generally win MVPs from their incredible scoring and offense. These players are somewhat more modern since the game has shifted focus from the big men dominated to guards and forwards being the dominant positions. This along with the popularization of 3-point shooting (which guards, and forwards are generally a lot better at) and increased pace of the game (more pace = more possessions = more chances to score) has led to many more modern MVP’s to be guards and forwards.

The blue box contains great “true point guards”: players who pass the ball a lot and run the offense. These players win MVP off of their amazing passing and impact on their team.

The green box has players who are great in multiple aspects of the game. They are tall and big, but they can handle the ball, run the offence like a point guard, defend well, and score the ball like guards. Very recent MVPs have been of this type, which might be a sign that these types of players will be the ones that dominate the MVP race in the future.

The single exception to any of the groups is Russell Westbrook, however, that is not too far from reality. Russell Westbrook is the second player in NBA history to average a “triple double”: double digits in 3 major statistical categories. More specifically, he averaged 32 points, 11 rebounds, and 10 assists. He scored like the players in the cyan group, assisted comparable to the players in the blue group, rebounded like the players in the black group, so it sounds like he should be in the green group with the other versatile players. However, he is 6 inches shorter than the shortest player in the green group and a slightly worse defender than the worst defender in that group. In other words, he is the biggest anomaly out of all the MVPs which the HC was able to pick up on even without a statistic for height.

### **3 Linear Regression**

Up to this point, this report has shed light on some of the nuances in the MVP award and what factors make guessing the MVP from historical data difficult. However, the aim of the report is still to try and predict the MVP to some extent. Seeing as how all the relevant data is numerical in this data set, linear regression is utilized to try to predict the number of scaled points that a candidate would win.

#### **3.1 The Process**

The benchmark of the linear regression model was a model that used all the variables with no interaction or second order terms. This model had an R-squared of 0.60 and an adjusted R-squared of 0.57.

During the experimentation with interaction terms, it was observed that even interaction terms deemed not significant were improving the R squared overall. This led to the idea to create a model that uses all the variables as well as every possible interaction term. The model had 596 predictors and a R squared of 0.97 and an adjusted R squared of 0.77. The forward selection model had lower R squared values. However, this model had a major issue: it was horrible at predicting. It explained the training set very well as shown by the R squared, however that did not correlate to being a good indicator of good predictions.

For the new approach to linear regression, the goal changed from getting a high R squared to getting a low average error of predictions. This goal better aligned with the objective of this report to predict the MVP. To do this, a loop was set up. The loop ran 250 times and each time it would define a random training and validation set. Then the loop would create a model using the training set and predict the validation set. The average error was recorded and added to a variable outside the loop that recorded all 250 average errors. Lastly the total average error was divided by 250 to get the average error of the model.

### 3.2 The Results

The best model in terms of least average error had an average error of 108 scaled points. The R-squared was 0.71 and the adjusted was 0.69. Significant variables with P-value less than 0.05 are summarized in the following table.

Table 3: Linear Model Significant Variables

Variable	P value	Significance Code
Games Played	0.018683	‘*’ 0.05
Points per game	0.029750	‘*’ 0.05
Field Goal Percentage	0.040781	‘*’ 0.05
Free Throw Percentage	0.028400	‘*’ 0.05
Wins	0.001194	‘***’ 0.01
Seed	0.023478	‘*’ 0.05
Player Efficiency Rating	0.000000000141	‘****’ 0.001
True Shooting Percentage	0.000583	‘****’ 0.001
Turnover Percentage	0.007287	‘***’ 0.01
Value Over Replacement Player	0.018283	‘*’ 0.05
Player Efficiency Rating Squared	< 0.0000000000000002	‘****’ 0.001
Player Efficiency Rating * Turnover Percentage	0.000004889883	‘****’ 0.001
Win Shares * Seed	0.000028422749	‘****’ 0.001
Win/Loss percent * Box Plus Minus	0.000031025429	‘****’ 0.001

### 3.3 Analysis

Interestingly enough, the variables with the lowest P values all relate with the idea that the MVP is the best player on the best team [2]. Other than arguably points, the variables don't have anything to do with the play style of the MVP. As was seen in figure 9 (dendrogram), the MVP has been awarded to player of all play styles, so no single play style was correlated to the amount of MVP votes. For example, if many of the significant variables were based on defense and rebounding and had positive coefficients, that would mean that big men, who generally have the best rebound statistics, would be at an advantage in MVP voting since those variables would be associated with higher MVP points. The most significant variables were variables that are position-less (not associated with any playstyle). For example, Player Efficiency Rating appears 3 times: solo term, as a second order term, and as part of an interaction term. PER takes into account everything a player does in a game therefore, it is not correlated to any specific player type. In other words, no matter the playstyle, the better player according to their stats will have the better PER.

### 3.4 Prediction

Table 4: 2022 MVP Points Predictions

Player	Predicted Points
Nikola Jokic	667
Giannis Antetokounmpo	576
Joel Embiid	403

As shown in table 4, the model has predicted that Nikola Jokic will win the most points for the 2022 MVP race with Giannis Antetokounmpo in second and Joel Embiid in third. The model suggests that the race will be fairly close especially if the model's average error is taken into account. Considering that the average error was 108, if Nikola hypothetically was overestimated by 108 while Giannis was underestimated by 108, then Giannis is the MVP. If Nikola was overestimated by 108 while Joel was underestimated by 157 (108 is just the average error, actual could be more), then Joel would have the most point. All this goes to show that all three men are capable of winning MVP and that the race is competitive. This sentiment is fairly similar to what has been observed in the media. All three performances

have been acknowledged as historical and there has been a lot of debate and back and forth about the MVP [4]. Jokic had the highest PER in NBA history while Joel is the first player at the center position to win the scoring title (average the most points in the season). Giannis (3 seed) has a noticeably higher seed than Jokic (6 seed) and only averaged about .6 less points per game compared to Joel while having a .9 higher PER. Giannis's PER is also only .7 less than Jokic's all time high PER. All this being said, just like the model, Jokic has been the favorite to win MVP for a majority of the season.

### **3.5 Take Away**

Though the results are not ideal, neither is the voting process. Working under the assumption that scaled votes is determined solely by these stats and with a linear relationship is a bold assumption. MVPs are voted for by sport analysts and broadcasters (like people on ESPN). Things like player narratives and voter fatigue (tired of voting for the same player to win MVP each year) have been said to play a role in MVP voting [5]. For example, Giannis has the second most votes in table 4, however, media members have said that, in their opinion, Giannis is behind Joel in the MVP race [6]. A part of the reason why that may be is that Giannis is a 2-time MVP already while Joel has not won one yet. Also, the MVP isn't necessarily the best player. For example, LeBron James has a great case to be the best player in the world for almost all of the 2010s, yet his last MVP season was in 2013.

Furthermore, the realization that a better R Squared did not lead to better predictions also supports the idea that the MVP is difficult to predict. The data set used in this report is of historical MVP candidates, and the fact that a model that better explains the historical data would be worse at predicting other candidates suggests that there are no simple set criteria. In other words, this suggests that there is context in conjunction with the stats that is difficult to account for in a mathematical model. For example, Russell Westbrook in 2017 had 879 points however the model (with Westbrook taken out of the training set) predicted that he would receive 659 votes. Even if we consider the average error of 108, an underestimate of 108 would still be 112 under what he received. However, that season Westbrook became the second player all time to average a triple double which was thought to be unbreakable at the time. On top of this, his former MVP teammate Kevin Durant left the summer prior in free agency to the team that beat their team in the playoffs. This created a lot of media attention

on Westbrook and some empathy as Westbrook was left as the lone star player on his team. These alternate factors are not factored into the data set. Sticking with Westbrook, the very next season he once again averaged a triple double and his team improved from 6<sup>th</sup> to 4<sup>th</sup> seed. However, he had only 75 points for MVP. That season, Westbrook gained 2 All-Star teammates and his PER and win shares had a noticeable drop, however, he also no longer had the wow-factor of averaging a triple double since this was his second year in a row doing so.

## 5 Classification

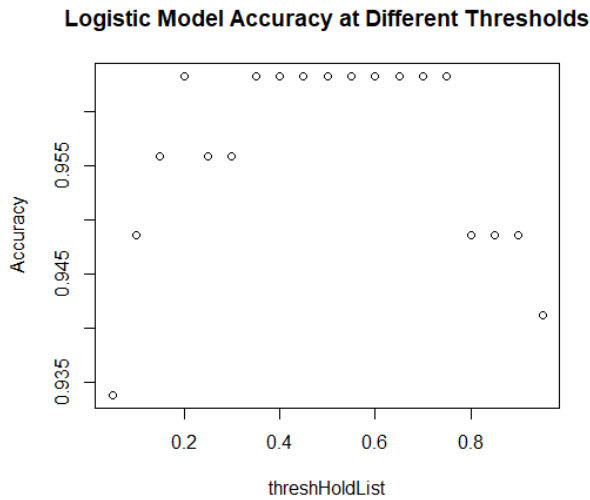
For classification, this report utilizes logistic regression. K nearest neighbor was considered since the goal is simply prediction, however, as shown in figure 9 (dendrogram), players tend to be grouped with other player of a similar play style. This would not be ideal for predicting MVP since play style does not determine who wins MVP as shown by the linear regression model.

Additionally, as shown in table 2 (clusters summary), many deserving players with higher points than previous MVPs did not win MVP due to their competition. Since these players were “MVP-worthy”, the MVP variable was changed so that any player with MVP points greater than or equal to 658 had a 1 in the MVP variable signifying that they are MVP caliber. 658 points was selected as the cutoff since it was the lowest number of MVP votes attained by a player that won the award. Logically, any player with 658+ points would win MVP given the correct competition.

Lastly, since MVP points is clearly associated with winning the MVP, the logistic model utilizes the same interaction and second order terms that were present in the linear model. The measure for accuracy was total correct divided by total possible. There were a many more players who didn’t win compared to those who did win which did inflate the accuracy, however, identifying who isn’t the MVP is part of identifying who is. Also, as this report has previously highlighted, sometimes the best/most statistically deserving player does not receive the MVP. Hypothetically, the “incorrect” guesses may have been the “correct” guess if there were no subjective outside factors.

## 5.1 Results

Table 5: Significant Variables



Variables With P Value Less than 0.001:
Win shares per 48 minutes
Usage percentage
Free throw attempt rate
Offensive rebound percentage

Figure 10: Accuracy at Thresholds

As shown in figure 10, the model is best at about a threshold of .5. The model was built multiple times and on average 0.5 had a good accuracy. The accuracy was shown to improve with forward selection and as such table 5 does not have as many significant variables. It is however interesting to note that a rebound statistic was very significant in the model since that caters to a specific play type.

## 5.2 Predictions

Table 6: Logistic Predictions for 2022 MVP

Player	Probability to Win	MVP Caliber
Nikola Jokic	60.19%	Yes
Giannis Antetokounmpo	35.73%	No
Joel Embiid	16.27%	No

The logistic model once again, as shown in table 6, predicts that Nikola Jokic will be the 2022 MVP. Behind him is Giannis and Joel in that order. This is similar to the linear model in the sense that Jokic had the most predicted points while Giannis and Embiid were behind him in that order. This model suggests a clear MVP favorite; however, Joel Embiid is still behind Giannis which is different from what the results of



the ESPN poll would suggest [6]. This again could suggest outside factors not accounted for in the data set such as how Joel Embiid has never won MVP in the past.

### **5.3 Take Away**

Although the model's accuracy was shown to be dependent on the validation set, the results of hierarchical clustering foreshadowed this to some extent. As was shown, the MVP's fall into certain groups based on certain play styles. If a training set has predominantly one type of MVP, the model will associate that play style with the being correlated MVP through specific stats. This is shown in the significant variables table of the logistic model as one of the significant variables was offensive rebound percentage which big men typically excel at. Proving the fact that the distribution of MVPs is affecting the model would require further study. However, intuitively, it does make logical sense. This assumption was the main reason that the model used to predict the 2022 MVP utilized the entire data set since the entire set has all different types of MVPs.

## **6 The Real Winner (Updated 10:30pm on May 11<sup>th</sup>, 2022)**

ESPN sources have said that Nikola Jokic has been voted MVP for the 2022 season [8]. The official point totals are 875 for Jokic, 706 for Joel, and 595 for Giannis. The linear model was off by 208 for Jokic, 303 for Embiid, and 19 off for Giannis. The model had Giannis with the second most points however, he had the third most in the real vote. Similarly, the logistic model predicted Giannis to have the second-best odds. The linear model was incorrect in the point totals and both models were incorrect in what the order of the candidates would be. However, when the average error of the linear model as well as the possible non-statistical factors that were discussed are taken into consideration, the shortcoming of the models becomes more understandable. To give credit where credit is due, the models both predicted that Jokic was the favorite to win by a fair margin. Also, they did predict the actual MVP correctly, which could be argued to be the most important part since that was the overarching goal of this project.

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