

# Trust the pRocess: NBA Award Predictions

STAT 385 SP2019 - Team Hurst

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## Abstract

This project will involve looking at 30 years of individual NBA player statistics. We will run an analysis using this historical data to develop a regression function for each individual regular season award in the NBA (Most Valuable Player, Defensive Player of the Year, Rookie of the Year, and Sixth Man of the Year). We will use this to determine every player's likelihood of winning each award. We will visualize these results using radar charts in a Shiny app.

## Contents

<b>1</b>	<b>Introduction</b>	<b>2</b>
1.1	Problem Statement . . . . .	2
1.2	Relevance . . . . .	2
1.3	Description of the data . . . . .	2
1.4	Connection to the Course . . . . .	2
<b>2</b>	<b>Related Work</b>	<b>2</b>
2.1	Previous Approaches . . . . .	2
2.2	Originality . . . . .	3
<b>3</b>	<b>Methods</b>	<b>3</b>
<b>4</b>	<b>Feasibility</b>	<b>4</b>
<b>5</b>	<b>Conclusion</b>	<b>4</b>
<b>6</b>	<b>Appendix</b>	<b>5</b>
6.1	Variables . . . . .	5
6.2	Formatting Notes . . . . .	7
	<b>References</b>	<b>8</b>

# 1 Introduction

## 1.1 Problem Statement

While fans and media pundits try to guess the winners of the major NBA awards (Most Valuable Player, Defensive Player of the Year, Rookie of the Year, and Sixth Man of the Year), the issue is that there's no real criteria or concrete way of predicting the winners of these awards. In this project, we seek to use historical data to predict these winners.

## 1.2 Relevance

Valuing player assets are important. Being able to accurately determine player value is one of the most fundamental skills in basketball front offices. Being able to do so accurately can be the difference between winning and losing. Many different subjects (statistics, differential equations, analytics) can be applied to these problems. With the success of Daryl Morey and Sam Hinkie, we see that these approaches have been successful in the NBA. Many interesting and unsolved issues in the NBA require statistical analysis, which is why we chose this project.

Our shared passion of basketball and the NBA led us to this topic. This is a topic that some of us have talked about and previous academic curiosity have led us to this topic. We wanted to know if we could use a variety of variables to accurately predict NBA Award winners.

## 1.3 Description of the data

The data is a series of dataframes of regular and advanced statistics spanning from 1989 and 2019. The statistics are listed and explained in the Appendix. Our data will come from the NBA Reference website. It will be 30 years of individual player data. The long time period and amount of data for our data points will allow us for a greater degree of accuracy and precision in the evaluation of our model.

## 1.4 Connection to the Course

We will be dealing with large datasets, validating data, and building statistical models. All of these skills form the foundations of statistical programming and we will apply what we have learned in our project.

# 2 Related Work

## 2.1 Previous Approaches

While not specifically related to this project, the application of sabermetrics has become a point of interest for many baseball teams. Likewise, we have begun to see this same transition in basketball analytics. The long term view of teams that have embraced analytics has been very good: the Philadelphia 76ers and Houston Rockets are both top seeded teams that have a significant chance at being the Championship team. While we haven't seen rigorous academic analysis of predicting NBA awards, there have been some implementations done by various individuals. There are also award trackers that just use raw data - specifically VORP (Value over Replacement Player) and PER (Player Efficiency Rating) and the player with the highest value is predicted to win. While these ways of predicting awards works somewhat well, they tend to have problems undervaluing certain players (the inventor of PER notes that it is not an end all metric - it rewards inefficient shooting and doesn't sufficiently reward effective defense) so our idea will be unique.

## 2.2 Originality

A lot of the statistics in use with modern publications are based on the research of one individual: Darryl Morey. We will derive our own variables and determine how impactful they are in determining wins using a regression model. By doing so, we will establish other variables and metrics that may be better suited for different situations and will allow for better comparison of players across time periods and eras.

## 3 Methods

First we use the `ballr` package (Elmore 2018) to pull the statistical data from (“Basketball Statistics and History,” n.d.)

The **methods** section should discuss how you plan to solve your problem. The overall details of the project including any preliminary work. In particular, the implementation details behind the approach should be explained at length here. The more details you can provide, the better feedback your group can receive. As a result, the section serves as a roadmap of what features are going to be developed and any external dependencies that are required. **The majority of your code should be *suppressed* from the displaying in this section.** Please refer to code and figures placed in the appendix. The latter can be referenced using:

Figure `\ref{fig:code-chunk-name-here}`.

For example, the figure of the data science workflow is accessible via Figure ??.

To satisfy this section, provide detailed responses for the following:

- What packages will you use in your implementation?
  - Data transformation: `tidyr`, `dplyr`, `ballr`
  - Data visualization: `ggplot2`, `plotly`, `gganimate`
  - Interactive Interface: `shiny`
  - Regression Analysis: `leaps`, `glmnet`, `caret`
- What code will the group need to write for the project?
  1. Code for importing the data
  2. Code for cleaning the pre-collected data and randomizing it
  3. Code to create the linear regression in obtaining the weights for each respective variables
  4. Code to create the toggle bar for the user interface input
  5. Code to create the interactive bar graph where it also displays the summary of the players
- Provide low-fidelity prototypes (e.g. *sketches* on paper) in the **Appendix** of:
  - Visualisations
    - \* What kinds of graphs will you use?

We will use a horizontal bar graph where the y-axis contains the player’s names and the x-axis contains the predicted percentage scores. We will put a picture of the athlete on the right side of their respective bars. The user will be able to interact with the graph by toggling on the face of the athlete and a word cloud will appear. The word cloud will consist of the google trending discussions on the athlete.

- \* Label axes, provide a title, and mention any interactivity.
  - Interface
    - \* All projects need a Shiny Application.
    - \* Sketch how a user will work with the shiny application.
- What have you done or learned so far for the project?

We have learned that we need to gather the statistical player data and filter them so that we have relevant data. We need to gather the variables and do regression to determine weights of each variables. We need to gather data on player discussion trends to project it in the graph. We also need to create a user interface where we get the user input data and graph the predicted results as well as the player statistics.

We are primarily wanting to ensure that your project has met the criterion of the data science pipeline. In essence, we want to see evidence that your project has:

- Reading data into *R* or accessing data via an API.
- Data transformations (e.g. Tidying (`tidyr`), Summarizing (`dplyr`), et cetera.)
- Data visualization (e.g. `ggplot2`, `plotly`, `gganimate`)
- R functions either in external packages or included in a new *R* package
- Interactive Interface (e.g. `shiny`)
- Reproducibility

## 4 Feasibility

The **Feasibility** section is meant to act as a way to reflect upon the proposal. Generally speaking, there will be three weeks of heavy development time afforded to the group. Building a detailed ecosystem or heavily scripting in a different language will likely not lead your team to success. Hence, please provide a project management overview of *who* on your team will be doing *what* and *when* by answering:

- Is this project able to be completed before the end of the semester?

It should be - while the data set is large, outside of the resource requirement, it should not be overly difficult to implement this specific idea. We will need to familiarize ourself with the specific data used here - lots of unique compiled stats are used in basketball as opposed to the typical counting stats.

- What steps must occur to complete the project before the end of the semester?

Accumulate the data in a timely manner - we must find what data we are going to use and apply our model to it. We plan to have 30 years worth of data so data cleaning/validation is an important and time consuming portion. We must also create specific derived variables that will more effectively illustrate the value of each player to their team for all the specific criteria. We must then model each of the awards - they will all have unique weights for each of the statistics.

- What is the work plan to accomplish the necessary tasks before the end of the semester?
  - Specify who is doing what and when.
  - Consider making a Gantt chart to highlight each stage of the project.
    - Ajay - obtain data (primarily from BBallRef) and create derived variables
    - Bhanu - build model and generate output (train model for each individual award)
    - Joshua and Eric - build visualization components of the Shiny app
    - Ajay and Bhanu - add sentiment analysis portion to visualizations (make a word cloud)

## 5 Conclusion

If you can accurately predict NBA awards, there is significant money to be made betting on winners of these awards. Additionally, by looking at this topic, NBA teams can get a better idea of what a winning player looks like, and can construct teams accordingly.

This project will involve looking at 30 years of individual NBA player statistics. We will develop a number of new advanced analytics and statistics to determine player efficient and value. Using these numbers, we will rank players and determine who should win prominent NBA awards. We will visualize these results using bar graphs and sentiment analysis.

## 6 Appendix

### 6.1 Variables

- player - name of the player
- pos - position
- age - age
- g - games played
- mp - minutes played
- per - player efficiency rating

$$per = (1/mp) * [3p + (2/3) * ast + (2 - factor * (ast_{team}/fg_{team})) * fg + (ft * 0.5 * (1 + (1 - (ast_{team}/fg_{team})) + (2/3) * (ast_{team}/fg_{team}))) - vop * tov - vop * drb \% * (fga - fg) - vop * 0.44 * (0.44 + (0.56 * drb \%)) * (fta - ft) + vop * (1 - drb \% * (drb) + vop * drb \% * orb + vop * stl + vop * drb \% * blk - pf * ((ft_{league}/pf_{league}) - 0.44 * (fta_{league}/pf_{league}) * vop)]$$

- tspercent - true shooting percent

$$tspercent = \frac{pts}{2 * (fga + (0.44 * fta))} * 100$$

- x3par - 3 point attempt rate - ows - offensive win shares

[10] "ftr" "orbpercent" "drbpercent" "trbpercent" "astpercent" "stlpercent" "blkpercent" "tovpercent" "usgpercent" [19] "ows" "dws" "ws" "ws\_48" "obpm" "dbpm" "bpm" "vorp" "gs"  
 [28] "fg" "fga" "fgpercent" "x3p" "x3pa" "x3ppercent" "x2p" "x2pa" "x2ppercent" [37] "efgpercent" "ft" "fta"  
 "ftpercent" "orb" "drb" "trb" "ast" "stl"  
 [46] "blk" "tov" "pf" "pts"

The **Appendix** section contains figures, sample data, and other miscellaneous entries. Generally, this sketch seeks to contain all of your *planning* information.

- Provide the sketches of visualisations and the shiny application.
- Provide an overview on the desired functions.
  - What is a function's input? Output? How are functions related to each other.
  - For example, `read_data("hospital_data.csv")` must be called before `tidy_hospital()`, et cetera.
- Provide a sample of the data set you intend to use (~10 observations).

##	PLAYER	TEAM	GP	W	L	W.	WQ	MIN	PTS	FGM	FGA	FG.
## 1	James Harden	HOU	81	54	27	0.667	0.506	36.4	29.1	8.3	18.9	44.0
## 2	Russell Westbrook	OKC	81	46	35	0.568	0.409	34.6	31.6	10.2	24.0	42.5
## 3	DeMar DeRozan	TOR	74	47	27	0.635	0.468	35.4	27.3	9.7	20.9	46.7
## 4	John Wall	WAS	78	48	30	0.615	0.467	36.4	23.1	8.3	18.4	45.1
## 5	Isaiah Thomas	BOS	76	51	25	0.671	0.473	33.8	28.9	9.0	19.4	46.3
## 6	Jimmy Butler	CHI	76	40	36	0.526	0.406	37.0	23.9	7.5	16.5	45.5
## 7	Damian Lillard	POR	75	38	37	0.507	0.379	35.9	27.0	8.8	19.8	44.4
## 8	LeBron James	CLE	74	51	23	0.689	0.543	37.8	26.4	9.9	18.2	54.8
## 9	Kyle Lowry	TOR	60	36	24	0.600	0.468	37.4	22.4	7.1	15.3	46.4
## 10	Andrew Wiggins	MIN	82	31	51	0.378	0.293	37.2	23.6	8.6	19.1	45.2
## 11	DeMarcus Cousins	NOP	72	30	42	0.417	0.297	34.2	27.0	9.0	19.9	45.2
## 12	Devin Booker	PHX	78	24	54	0.308	0.224	35.0	22.1	7.8	18.3	42.3
## 13	Kyrie Irving	CLE	72	47	25	0.653	0.477	35.1	25.2	9.3	19.7	47.3
## 14	Kawhi Leonard	SAS	74	54	20	0.730	0.508	33.4	25.5	8.6	17.7	48.5
## 15	Stephen Curry	GSW	79	65	14	0.823	0.573	33.4	25.3	8.5	18.3	46.8

```
## 16      Blake Griffin  LAC 61 40 21 0.656 0.464 34.0 21.6  7.9 15.9 49.3
## 17      Gordon Hayward UTA 73 46 27 0.630 0.453 34.5 21.9  7.5 15.8 47.1
## 18      Eric Bledsoe   PHX 66 22 44 0.333 0.229 33.0 21.1  6.8 15.7 43.4
## 19      Goran Dragic   MIA 73 40 33 0.548 0.385 33.7 20.3  7.3 15.4 47.5
##      X3PM X3PA X3P. FTM  FTA  FT. OREB DREB  REB  AST TOV STL BLK  PF
## 1      3.2  9.3 34.7 9.2 10.9 84.7  1.2  7.0  8.1 11.2 5.7 1.5 0.5 2.7
## 2      2.5  7.2 34.3 8.8 10.4 84.5  1.7  9.0 10.7 10.4 5.4 1.6 0.4 2.3
## 3      0.4  1.7 26.6 7.4  8.7 84.2  0.9  4.3  5.2  3.9 2.4 1.1 0.2 1.8
## 4      1.1  3.5 32.7 5.4  6.8 80.1  0.8  3.4  4.2 10.7 4.1 2.0 0.6 1.9
## 5      3.2  8.5 37.9 7.8  8.5 90.9  0.6  2.1  2.7  5.9 2.8 0.9 0.2 2.2
## 6      1.2  3.3 36.7 7.7  8.9 86.5  1.7  4.5  6.2  5.5 2.1 1.9 0.4 1.5
## 7      2.9  7.7 37.0 6.5  7.3 89.5  0.6  4.3  4.9  5.9 2.6 0.9 0.3 2.0
## 8      1.7  4.6 36.3 4.8  7.2 67.4  1.3  7.3  8.6  8.7 4.1 1.2 0.6 1.8
## 9      3.2  7.8 41.2 5.0  6.1 81.9  0.8  4.0  4.8  7.0 2.9 1.5 0.3 2.8
## 10     1.3  3.5 35.6 5.0  6.6 76.0  1.2  2.8  4.0  2.3 2.3 1.0 0.4 2.2
## 11     1.8  5.0 36.1 7.2  9.3 77.2  2.1  8.9 11.0  4.6 3.7 1.4 1.3 3.9
## 12     1.9  5.2 36.3 4.7  5.7 83.2  0.6  2.6  3.2  3.4 3.1 0.9 0.3 3.1
## 13     2.5  6.1 40.1 4.1  4.6 90.5  0.7  2.5  3.2  5.8 2.5 1.2 0.3 2.2
## 14     2.0  5.2 38.0 6.3  7.2 88.0  1.1  4.7  5.8  3.5 2.1 1.8 0.7 1.6
## 15     4.1 10.0 41.1 4.1  4.6 89.8  0.8  3.7  4.5  6.6 3.0 1.8 0.2 2.3
## 16     0.6  1.9 33.6 5.2  6.9 76.0  1.8  6.3  8.1  4.9 2.3 0.9 0.4 2.6
## 17     2.0  5.1 39.8 5.0  5.9 84.4  0.7  4.7  5.4  3.5 1.9 1.0 0.3 1.6
## 18     1.6  4.7 33.5 5.9  6.9 84.7  0.8  4.1  4.8  6.3 3.4 1.4 0.5 2.5
## 19     1.6  4.0 40.5 4.1  5.2 79.0  0.8  3.0  3.8  5.8 2.9 1.2 0.2 2.7
```

If you used previous code chunks within the document, this information can be dynamically retrieved and embedded.

```
# Sets default chunk options
knitr::opts_chunk$set(
  # Figures/Images will be centered
  fig.align = "center",
  # Code will not be displayed unless `echo = TRUE` is set for a chunk
  echo = FALSE,
  # Messages are suppressed
  message = FALSE,
  # Warnings are suppressed
  warning = FALSE
)

# All packages needed should be loaded in this chunk
pkg_list = c('knitr', 'kableExtra', 'magrittr', 'bookdown')

# Determine what packages are NOT installed already.
to_install_pkgs = pkg_list[!(pkg_list %in% installed.packages()[,"Package"])]

# Install the missing packages
if(length(to_install_pkgs)) {
  install.packages(to_install_pkgs, repos = "https://cloud.r-project.org")
}

# Load all packages
sapply(pkg_list, require, character.only = TRUE)
example = read.csv("example.csv")
print(example)
kable(
```

```

head(mtcars, 20),
format = "latex",
caption = "This is an example of a table in the Appendix. Notice that it is way too big, and has way too many columns.",
booktabs = TRUE
) %>%
kable_styling(latex_options = c("striped", "scale_down"))
kable(
  head(mtcars, 20),
  format = "latex",
  caption = "This is another example of a ridiculous table. Notice that it is automatically numbered.",
  booktabs = TRUE
) %>%
kable_styling(latex_options = c("striped", "scale_down"))

```

## 6.2 Formatting Notes

### 6.2.1 R Code and rmarkdown

An important part of the report is communicating results in a well-formatted manner. This template document should help a lot with that task. Some thoughts on using R and `rmarkdown`:

- Chunks are set to not echo by default in this document.
- Consider naming your chunks. This will be necessary for referencing chunks that create tables or figures.
- One chunk per table or figure!
- Tables should be created using `knitr::kable()`.
- Consider using `kableExtra()` for better presentation of tables. (Examples in this document.)
- Caption all figures and tables. (Examples in this document.)
- Use the `img/` sub-directory for any external images.
- Use the `data/` sub-directory for any external data.

### 6.2.2 LaTeX

While you will not directly work with LaTeX, you may wish to have some details on working with TeX can be found in this guide by UIUC Mathematics Professor A.J. Hildebrand.

With `rmarkdown`, LaTeX can be used inline, like this,  $a^2 + b^2 = c^2$ , or using display mode,

$$\mathbb{E}_{X,Y} [(Y - f(X))^2] = \mathbb{E}_X \mathbb{E}_{Y|X} [(Y - f(X))^2 \mid X = x]$$

You **are** required to use BibTeX for references. With BibTeX, we could reference the `rmarkdown` paper or the tidy data paper. Some details can be found in the `bookdown` book. Also, hint, Google Scholar makes obtaining BibTeX reference extremely easy. For more details, see the next section...

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