

Project Proposal

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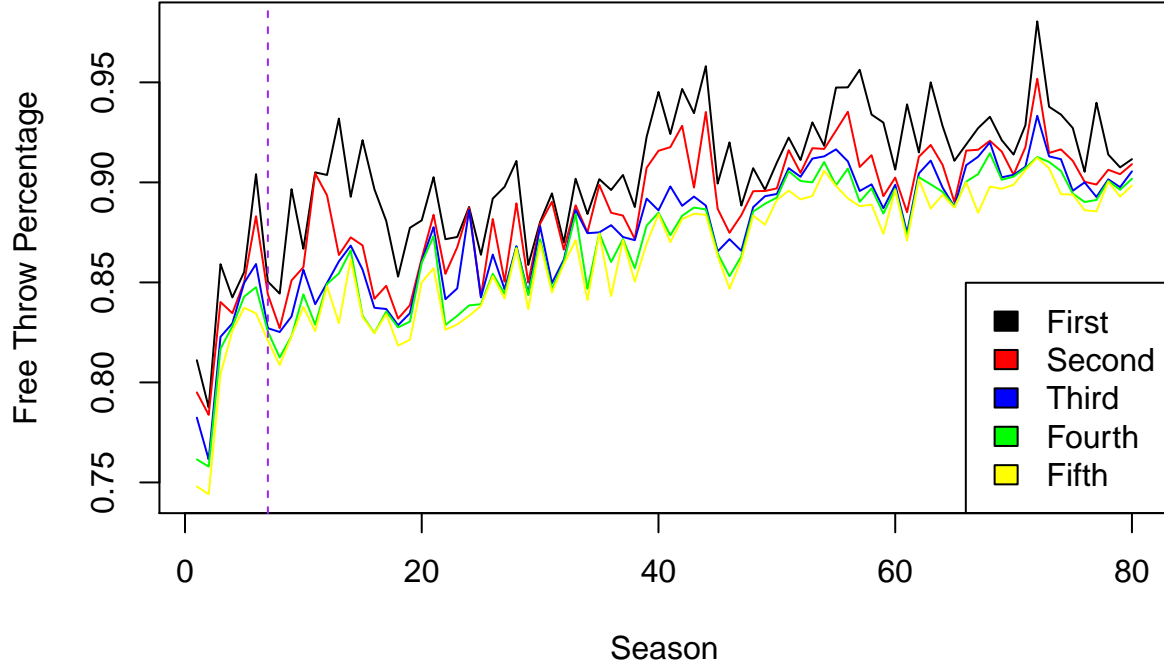
The goal of this project is to determine if there is a limit for an NBA player's free throw percentage in a season. Free throws are one of the most unique opportunities in sports where a player is given a "free" uncontested attempt to score. Ideally, a player should make every free chance they get by shooting 100% of their free throws, yet no NBA player has ever completed this feat for a whole season. With NBA players shooting better and better each season as of recently, a burning question for many NBA fans is: Is it possible to achieve a perfect free throw season making every shot one takes? I will use extreme value theory estimation to determine the best conceivable free throw percentage for an NBA player in a season.

The dataset was taken from Basketball Reference (<https://www.basketball-reference.com/>). This website is a comprehensive source for various statistics in basketball's history, most specifically the NBA. I pulled the top 10 NBA individual players' free throw percentages for each season from 1947-2017 (80 seasons total). Here is a preview of the dataset:

##	Season	Lg	X1st	perc1	X2nd	perc2	X3rd	perc3
## 1	2016-17	NBA	C. McCollum	0.9116	I. Thomas	0.9091	K. Irving	0.9055
## 2	2015-16	NBA	S. Curry	0.9075	J. Crawford	0.9041	K. Durant	0.8976
## 3	2014-15	NBA	S. Curry	0.9139	J. Meeks	0.9063	J. Redick	0.9015
## 4	2013-14	NBA	B. Roberts	0.9398	D. Nowitzki	0.8989	R. Jackson	0.8927
## 5	2012-13	NBA	K. Durant	0.9053	S. Curry	0.9003	J. Redick	0.9000
## 6	2011-12	NBA	J. Crawford	0.9272	J. Redick	0.9108	D. Nowitzki	0.8958

I have begun exploratory analysis on this dataset. Here is a plot of the top 5 free throw percentages from each of the 80 NBA seasons in this dataset.

Top 5 Free Throw Percentage Performers



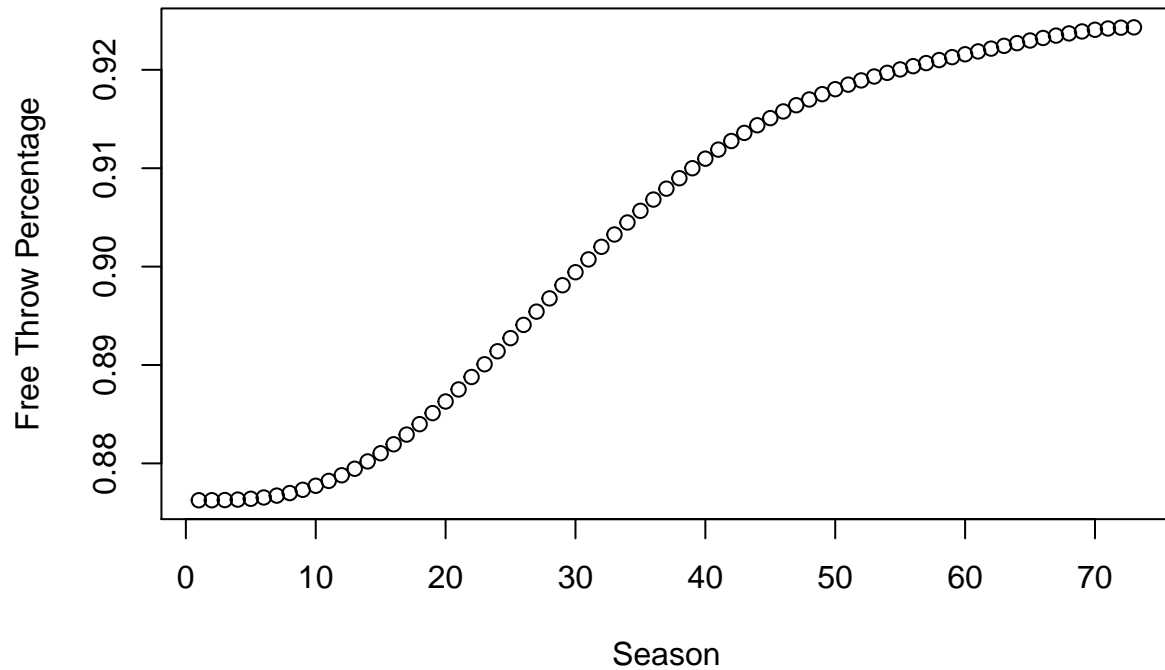
When the NBA first began in the late 1940s to early 1950s, players were still adjusting to the league's rules so there is a rapid improvement in NBA free throw percentages that is unlikely to happen again. However, there is still a slight, fairly stable improvement in free throw percentages from then onward. My goal is to model this upward trend and determine if there is a top limit besides the obvious 1.00. I will attempt to use the generalized extreme value (gev) distribution.

The pdf is defined as: $f(x) = \frac{1}{\sigma} \left(1 + \xi \frac{x-\mu}{\sigma}\right)^{-\frac{1}{\xi}-1} e^{-(1+\xi \frac{x-\mu}{\sigma})^{-\frac{1}{\xi}}}$.

The generalized extreme value (gev) distribution takes three parameters: location $\mu(t)$, scale σ , and shape ξ . The location parameter depends on time (how many seasons we use). This is the key parameter to model. I plan on using and evaluating the fit of various non-linear implementations for this location parameter including a splines approximation and a gompertz curve.

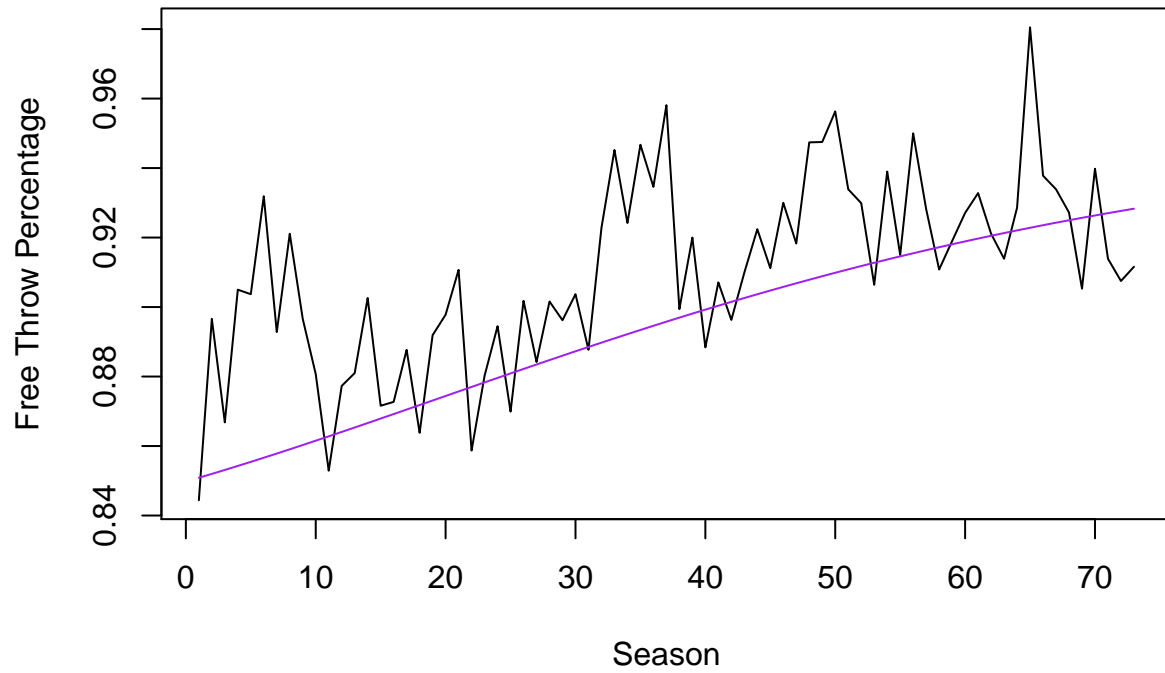
The splines approximation approach uses the {splines2} package written by Wenjie Wang and Jun Yan. This technique takes in a degrees of freedom value and number of knots to approximate a polynomial curve. I can fit a splines matrix as the location parameter $\mu(t)$ of the gev distribution to fit to the free throw data. Below is the splines fitting to the top 1 NBA free throw percentage of each season.

Splines Fit to the Top Free Throw Percentage Each NBA Season



The gompertz approach uses the gompertz function defined as: $f(t) = ae^{-be^{(-ct)}} + z$ which is a function of time t . a is an asymptote, b describes where the curve is placed on the x axis, c is the growth rate, and z is the intercept. I can fit a gompertz curve as the location parameter $\mu(t)$ of the gev distribution to fit to the free throw data. Below is an example of a gompertz function implemented as the location parameter in the gev distribution fitted to the NBA free throw data.

Top 5 Free Throw Percentage Performers



I will then evaluate the estimated limit on NBA free throw percentage in an NBA season including confidence intervals. I will compare the different approaches and evaluate the fits. I will then interpret what these results mean for NBA fans.