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NBA Elo

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Final Report

1. Introduction

Elo is a zero-sum rating method that is used to calculate the relative skill level of players in games such as chess. However, Nate Silver was able to take this method and modify it into a rating method that we can use on other sports. In this situation, Elo is a method that can be used to rank NBA teams across decades of play, and it is a fairly simple model. All that it takes into consideration is the final score of the game, when it was played, and where it was played. Elo ratings are given per game, not for the season. A team will always gain Elo points for winning but can get more points by having larger margins of victory or upsetting higher ranked teams. Because Elo is a zero-sum rating method, if one team gains x points, another team will have to lose x points. An average Elo rating is about 1500. This project looks at Elo ratings of teams and decides if it is an accurate way to determine playoff teams and a team's total number of wins at the end of the season. It also performs a clustering classification based on Elo and win percentage to predict playoff teams.

2. Related Work

In this dataset, many values were given such as home team, away team, game date, final scores, home and away team Elo before and after the game, and game location. From this data, many graphs were created showing how a team's Elo changes over time, pointing out when they reached their peak Elo. I went and regenerated all of the Elo plots for each team – current teams and past teams. I then picked three teams – the Lakers, Bulls, and Pistons- to also find when the team reached their peak Elo, along with comparing their Elo over time to the average. Below are those three plots. The Bulls reached a peak Elo value of 1853.1045 on June 9th, 1996. The Lakers reached their peak Elo of 1789.9934 on June 14th, 2009. The Pistons reached their peak Elo of 17 88.0909 on June 13th, 1989.

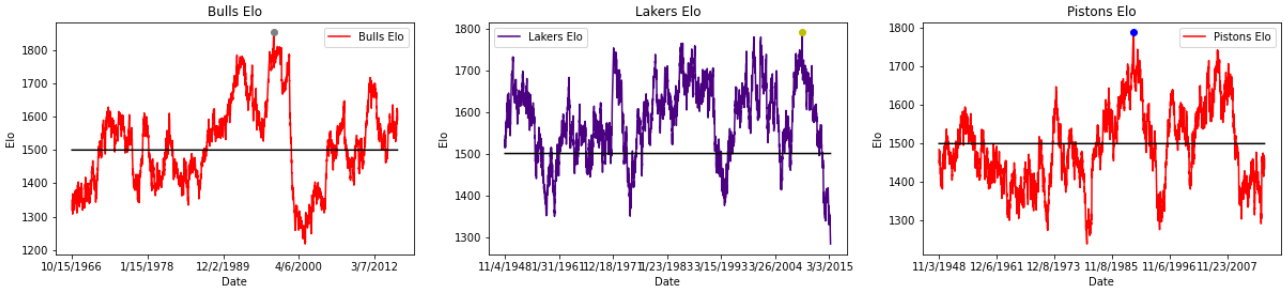

Figure 1: Plots showing Elo ratings throughout the seasons for the Bulls, Lakers, and Pistons

Previous analysis of this data also looks at what Elo values correlate to what game records. For example, a 1500 Elo is average, or a 41-41 record. Based off of this, it is able to give a projected record for the end of the season at any point during the season, and update it after every game, based on if that team's Elo is increasing or decreasing. The previous analyses also looked at which teams were predicted to make the playoffs and what chance they had in addition to their chances of making and winning the finals. All of these previous analyses are from FiveThirtyEight and Nate Silvers.

3. Data

The main data that was used for this project was a compilation of results and other information from every basketball game from every team from 1946 to 2015. This includes teams from the NBA and ABA. It is current teams along with teams that are no longer around. This data has 126,314 observations and 23 features. However, each game is in the data set twice- once for the home team and once for the away team- so once the duplicates are removed, there are only 63,157 observations. I then went and added a 24th feature to this data set- what season the game was in. The data set gave us a feature that was year id, however this can be slightly misleading if the game happened in the earlier part of the season. I did not remove any features.

The other data that was used for this project was three smaller data sets, one for the 2012-13 season, one for the 2013-14 season, and one for the 2014-15 season. These data sets each had 30 observations with six features- team, number of wins, number of losses, win percentage, if they made the playoffs, and what conference they were in. These data sets were used for comparison when the Elo data set was split up into these three seasons.

4. Methods

Many different methods were used within this project. The first thing done was three seasons of data were separated, so I could focus in on single seasons. The three seasons were 2012-13, 2013-14, 2014-15. I used k-means clustering to try and predict payoff teams and how this compared to the actual playoff teams. I also looked at if straight Elo values could be used to help predict playoffs, along with if Elo could be used to predict a team's final record of the season.

4.1 Plotting

The first thing that was done for each season was plotting the Elo values of each team throughout the season. I made three separate plots: one that was the entire season, one that was only pre-playoffs, and one that was only playoffs. Below is the 2012-13 full season plot, 2013-14 pre-playoffs plot, and the 2014-15 playoffs plot. In the all games plot and the playoffs plot you can notice how some of the teams Elo stops before the others teams. This is because if the team did not make the playoffs, or they lost in the playoffs, they no longer had Elo values being recorded for new games.

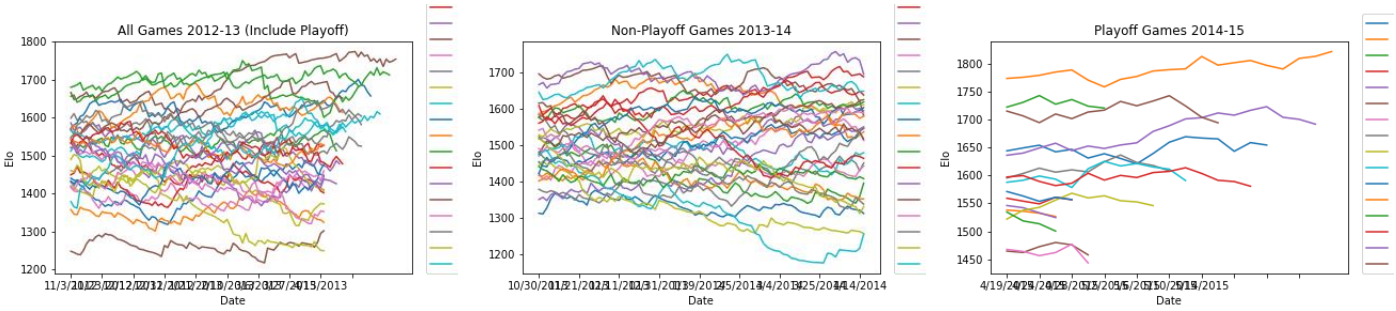

Figure 2: Plots displaying multiple teams Elo ratings throughout a season.

4.2 K-Means Clustering

K-means clustering was used in the project to attempt to predict what teams would make the playoffs. The number of clusters was set to two (make the playoffs, do not make the playoffs). The data given to make the clusters was the team's final Elo score after the regular season along with the team's win percentage after the regular season.

4.3 Straight Values

Another method that was used to attempt to predict the playoff teams was just straight Elo values. The Elo value for each team after their final regular season game was used. Those values were sorted and the top 16 were the teams that made the playoffs.

However, the playoffs in not just the top 16 teams in the league, it is the top eight from each conference. With this in mind, the teams were then split up into the east and west conferences. The same approach as before was taken, however this time the top eight teams were taken from each conference. Once the league was split up into their conferences, the errors went down slightly.

4.4 Categorization

Another method used in this project was categorization. Based off of the Elo value, each team was categorized into a range of wins for the season. For example, if a team had an Elo score between 1600 and 1700 it had between 51 and 60 wins. This prediction was then compared to the

actual number of wins the team had that season. This method was not as successful as predicting the playoff teams.

5. Results

As previously stated under methods, the data was split up in 3 subsets based off of the season. These subsets include all of the games for each season for the 2012-13, 2013-14, and 2014-15 seasons. For all three of the seasons, the same approaches were taken on the data, and the results were compared to find an average result.
When I used the k-means clustering method, fitting the model with the final Elo score and win percentage for each team in the regular season, I found that while testing this method across the three different seasons, an error of about 25% resulted. This means that about 75% of the teams that made the playoffs were correctly predicted.

Elo ratings were also used to predict playoff teams. The first way that was attempted was by taking the top 16 Elo scores of all teams. For all three seasons, only two teams were incorrectly predicted to make the playoffs this way. However, the model was the slightly rethought to include each teams conference- playoffs is actually top 8 teams from each conference, not just top 16 teams from the whole league. With this approach, for two of the seasons, it incorrectly predicted one team, and for the third season it incorrectly predicted two teams. This was a slight decrease in error from the first attempt using Elo ratings.

I also attempted to find the range of wins that a team would achieve based on their final Elo rating of the regular season. For most Elo ratings, a range of 100 Elo points was equal to a range of about 8 or 9 games. For across the three seasons, this method accurately predicted about 70% of team's final number of wins.

6. Discussion and Conclusion

Overall, the Elo rating is a good system for rating teams in the NBA. It can be used as a good way to compare teams to one another across seasons as well. It is a simple model that can be calculated only based off of final score of the game, and when and where it was played. This project was used to help determine if Elo ratings could be used to predict what teams would advance to the playoffs. It also tried to predict a team's overall number of wins.

In conclusion, yes- Elo is a good method to predict playoff teams. When the NBA was split into the East and West Conferences, using the Elo value resulted in minimal error when picking playoff teams. However, one thing that the Elo ratings do not take into account is the play-in games. The seventh, eight, nineth, and tenth place teams play for a spot in the playoffs. Elo just takes the top eight in each conference. If this project were to be reproduced, this system of the play in games could maybe try to be included.

From this project, straight Elo ratings did a better job of predicting the playoff teams than the clustering method did. For the clustering, the data was given as the final Elo for the regular season and the teams win percentage. If this input was tweaked, or other parameters were altered, it is possible that the k-means clustering method could produce better results with a smaller error rate than the current model that I have. One parameter that would not be changed though would be the number of clusters. This is due to the fact that the two clusters represent playoff teams and non-playoff teams. One other issue with the clustering method is it did not even predict the correct number of teams for the playoffs.

Clustering may not be the best approach to picking the playoff teams also due to the fact that there may not always be a super clear line between playoff and non-playoff teams. Sometimes it can come down to a one game difference between two teams as to who makes the playoffs and who does not. In addition, clustering does not take into account the two different conferences. One solution to that could be to create two different clustering models, one for the East Conference and one for the West Conference.

Elo rating did not do as well of a job predicting the number of wins for each team at the end of the regular season. I think that this is something that could be improved upon in my model. I think in my model, I compared final Elo ratings, including the playoff games, to the records at the end of the season instead of comparing Elo ratings at the end of the season pre-playoffs to the number of wins. With this small tweak, Elo ratings may do a better job of predicting the number of wins for a season.

Overall, there are ways that this project could be improved. However, I think it does go to show that Elo ratings are a good method that can be used to help predict playoff teams and wins, along with comparing teams across seasons within the NBA.

References

Brownlee, Jason. “10 Clustering Algorithms With Python.” *Machine Learning Mastery*, 20 Aug. 2020, machinelearningmastery.com/clustering-algorithms-with-python/.

NateSilver538. “2020-21 NBA Predictions.” *FiveThirtyEight*, FiveThirtyEight, 19 Apr. 2021, projects.fivethirtyeight.com/2021-nba-predictions/.

natesilver538. “How We Calculate NBA Elo Ratings.” *FiveThirtyEight*, FiveThirtyEight, 21 May 2015, fivethirtyeight.com/features/how-we-calculate-nba-elo-ratings/.

Person. “Replicating Nate Silver's NBA Elo Algorithm.” *Ergo Sum*, 30 Apr. 2018, www.ergosum.co/nate-silvers-nba-elo-algorithm/.

Reubenfb. “The Complete History Of The NBA.” *FiveThirtyEight*, FiveThirtyEight, 7 Dec. 2015, projects.fivethirtyeight.com/complete-history-of-the-nba/#lakers.