National Basketball Association League Realignment

21-393 Final Project

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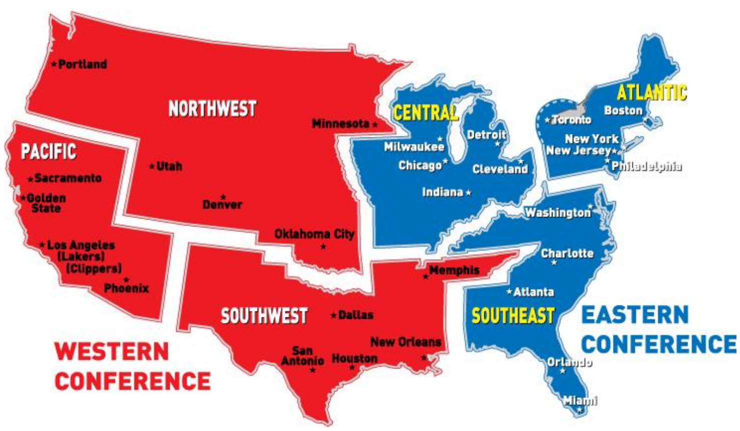
1 Abstract

Our project aims to realign the national basketball association to equate the strength of teams within each conference while also taking into consideration the travel distances between the teams. The objective function seeks to minimize the difference in interleague wins between the two conferences, and to minimize the distance travelled with a scaling factor. The algorithms used to find feasible final solutions are a randomized stepwise procedure and a breath-first search that converges to a local minimum. We conclude that our algorithms provide a league alignment that is much more competitive than the current alignment.

2 Background and Problem

There are thirty teams in the NBA. The league is divided into two conferences, Eastern and Western. The Western conference has three divisions called the Northwest, Pacific and Southwest. The Eastern conference has three divisions called the Atlantic, Central and Southeast. Each division contains five teams.



Each team in the NBA plays 4 games against the other 4 division opponents, 4 games against 6 (out-of-division) conference opponents, 3 games against the remaining 4 (out-of-division) conference opponents, and 2 games against teams in the opposing conference. It is consensus that the current conference alignment is imbalanced. The Western conference is known to contain better teams than the Eastern conference. Since the majority of each teams' games are played against conference opponents, it is easier to record more wins in the Eastern conference than the Western. Furthermore, the playoffs are organized in a single elimination within the conferences with the two winners each other playing for the championship. Teams in the Western conference often suffer from fatigue and injury as they play highly competitive games in the playoffs, which sometimes lead to an advantage for the Eastern conference champion when they meet in the final game.

We seek to organize the league equate the strength of teams within each conference. Firstly, we need a metric of how good each team is. There are many ways to do this, we could consider number of all-star players, points scored per game, points differential per game, wins differential for the season and several different metrics. Each metric has its flaws, such as the possibility that all-star players don't play well together or that offensive-minded teams will have more points per game despite surrendering more points as well.

3 Objective Function

We decided that the number of wins in the past season should be the metric used, because it considers how well each team plays throughout the entire 82-game season (having multiple all-star players does not guarantee that they play well together).

More importantly, we consider the number of wins each team has against the other teams in the other conference. Minimizing the aggregate interleague wins ensures that each conference is highly competitive.

We also consider travel time between the cities within each conference. While having a completely balanced league is desirable, in an 82-game season, teams often play three or four games a week, so travelling to away games is a major contributor to players' fatigue and performance.

Our objective function seeks to minimize the difference in past season wins between the two conferences. The distance consideration is included as a penalty in the objective function, as we aim to minimize travel as well. Specifically,

$$Z = \min \{ |\text{West\_Interleague\_Wins} - \text{East\_Interleague\_Wins}| + \mu (\text{Travel\_Per\_Game} + \text{Max\_Travel}) \}$$

where μ is a constant.

4 Data Collection and Processing

4. 1 Win Aggregates

We collected game data in the form of scores from all the games played in the NBA last season from an online source[1]. We used this data to compute the win aggregates for each matchup in the schedule, i.e. the Atlanta Hawks have 2 wins against the Boston Celtics, and the Boston Celtics have 1 win against the Atlanta Hawks.

4. 2 Travel Distances

We obtained the distance each team must travel to each matchup from an online source[2]. Notice that the distance team A must travel to team B is not necessarily the same as the distance team B must travel to team A. This is because the teams do not necessarily use the same route to travel back and forth.

5 Algorithm

We take a random initial feasible solution by picking fifteen teams to be in the Eastern conference, and putting the rest in the Western conference. We then calculate the aggregate number of wins each team has against the teams in their conference.

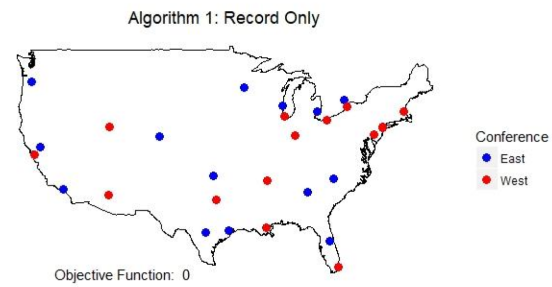
We use two algorithms to arrive at a final solution from the initial feasible solution. The first is a randomized stepwise procedure that takes a random team in the East and swaps it with a random team in the West. It then combs through the win aggregates data again to recalculate the value of the objective function. If it is higher than the previous value, we swap the teams. The algorithm arrives at the final solution after 1000 iterations.

The next algorithm considers all the possible single-swap changes to the division. It iterates through all possibilities and calculates the value of the objective function for each single-swap. The algorithm takes the result that has the lowest value for the objective function. After many iterations, the algorithm will converge to a local minimum when there are no more single-swap changes that lower the objective function.

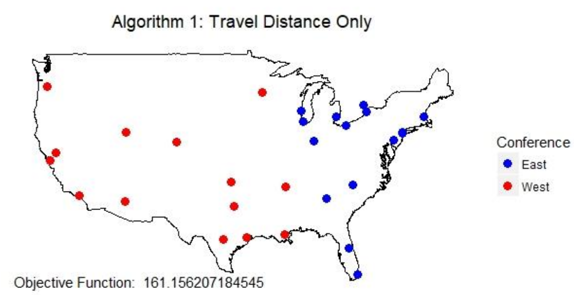
The breath-first search is more rigorous as it checks every possibility. As such, it has a longer runtime, but needs much fewer iterations to arrive at the final solution. We notice that both algorithms converge to very similar solutions, even when starting from a random initial solution.

6 Results

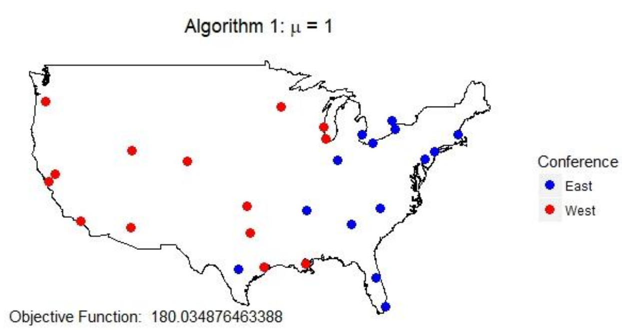
We first run the randomized stepwise algorithm without the penalty for travel distance, in other words, μ = 0. The result is extremely competitive conferences. In fact, the objective function is zero at the optimal solution. The realigned conferences are shown in the image on the right.



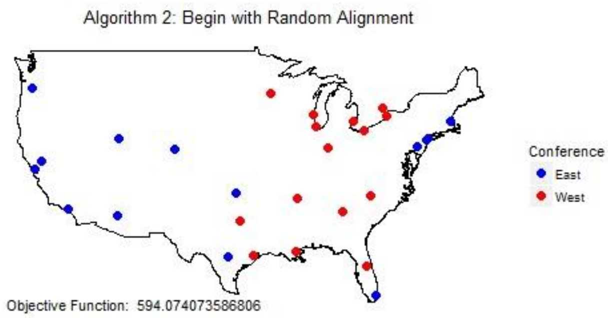
We then run the algorithm considering travel distance only, by setting a large value for μ. The resulting alignment is shown in the image on the right. Unsurprisingly, the conferences are just separated into eastern teams and western teams.

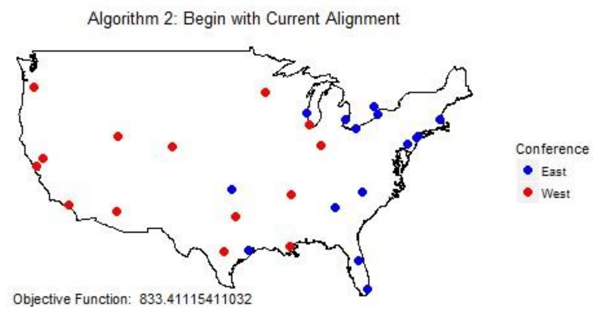


We then run the algorithm considering both travel distance and interleague competitiveness. We set a value of 1 for μ. The realigned conferences are shown in the image below. The optimal objective function is higher, as expected, than the objective function in the travel distance only model.



We then run the breath-first algorithm, setting a value of 0.35 for μ. We ran the algorithm starting with a random initial conference alignment and starting with the current conference alignment. The resulting realignments are shown in the image below. The optimal objective function is around 594 and 833 respectively.





7 Conclusion and Further Considerations

Based on our investigation, our algorithms provide a league alignment that is much more competitive than the current alignment. It seems that the talent discrepancy within the conferences can be much improved. However, we realize that the national basketball association may not prioritize competitiveness within conferences as much as other factors such as team rivalries, playoff competitiveness or game attractiveness to the fans.

It is consensus that the current Western conference is stronger than the Eastern conference. This gives teams in the Eastern conference advantages as they play weaker teams throughout the season and experience less fatigue, as well as having a easier route in the playoffs. Our methods that equalize talent distribution over the two conferences removes such advantages and provides a more competitive basketball league.

A common problem with league realignment is the frequency that it should be performed. Since teams often trade multiple players between seasons, the skill level of teams can change by a significant amount every season. If the goal is to maintain interleague competitiveness, then it makes sense to perform realignment every season. However, it may be unreasonable to change the conferences every year as this does not give time for teams to adapt and develop to challenges within their divisions.

Another possible consideration for future explorations is the conservation of old rivalries and other highly-anticipated games. There are several fan-favorite rivalries and matchups that should be preserved. This can be added as a constraint to preserve certain matchups and use the same algorithms to find a final solution.

8 References and Sources

1. https://www.basketball-reference.com/leagues/NBA_2017_games
2. http://mileage-charts.com/
3. https://arxiv.org/abs/1302.4735