NCAA Women's Ranking: Home Court Trajectories Study

Casey Lee

For this paper, I have been provided feedback by both the GSI and my peer Zhiling Huang has helped me enhance the writing of my paper for Unit 3. After consideration and review of all the comments and suggestions, I made a few changes made to each section of the paper:

- In the Introduction section, I wrote a sentence in regards to foreshadowing the key findings or insights the model revealed and how these results will be helpful.
    - "It provides us key insights in regards to the teams and how game location does affect the performance of the basketball teams. We then observe the confidence intervals of each team and conduct a hypothesis test by incorporating the Bonferroni correction to control for a familywise error. We are able to determine from the pair of rival teams to see who is a strong opponent."
- In the Methods section, I added a citation for the dataset, as my peer has noted.
    - "The dataset of the Division I women's basketball games through March 16, 2025 was from the University of Michigan: http://stat.lsa.umich.edu/~bbh/s485/data/cbb-womens-2025-03-16.csv.
    - I also added assumptions for the Bradley-Terry model and provided more insights as to what it means in the context of this paper based on the feedback I received from both my GSI and my peer reviewer.
    - I did not add why AIC was chosen to evaluate model fit, as I believe I explained in one sentence but I did try to make it more clear.
- In the Results section, I added a more insightful caption for the tables as the GSI stated, and I added a hypothesis testing to the results section, as I did not add it in my first paper.
- In the Discussion section, I added a sentence about bias: "While home-court advantage does play a role, we also have to consider that some teams played at home more often than others, which means that there could be slight bias, so we are not able to fully trust the coefficients of the model for those teams. "
- Lastly, I broke up the larger paragraphs for the readers to understand the paper more clearly, as the intended audience is not statisticians or researchers just as my peer reviewer stated in the feedback.
- I also did not utilize any resource besides getting the dataset from the University of Michigan, which was I did not incorporate that at the end of my paper, as my peer reviewer stated in the feedback.

Introduction

College basketball fans watch the NCAA tournament, consisting of 68 collegiate teams competing to be the champion. The method of the NCAA ranking of 68 teams for the NCAA women's tournament raises questions on whether or not the ranking reflects the true performance of the basketball teams. This study further seeks to answer the question of whether or not team ranking systems reflect or not reflect the true win-loss records due to other variables such as home advantage. The dataset of the Division I women's basketball games through March 16, 2025 was from the University of Michigan: http://stat.lsa.umich.edu/~bbh/s485/data/cbb-womens-2025-03-16.csv.

To explore this data, the Bradley-Terry model was used as it helps determine the ranking of the women basketball teams of the 2024-2025 season, examining the teams' abilities and performance. I implemented a few models: a plain-vanilla Bradley-Terry model, a penalized model of logistic regression, and a refined model incorporating game location by adding parameters for home-court advantage and allowing team strengths to evolve throughout that season. By comparing each model's results, we try to see which model captures the overlooked variables such as game location to consider home advantage. For our paper, the best-fitting model was model 3, the Bayesian-penalized BT with home advantage, as it showed a better tradeoff between the goodness-of-fit and coefficients, meaning it has a better model fit. It provide us key insights in regards to the teams and how game location does affect the performance of the basketball teams. The resulting analysis provides insight for team rankings,

specific outcomes for Michigan and other teams. I ranked the top 10 teams and the bottom 5 teams based on the chosen model and determined the odds of Michigan winning against each of the 3 teams it played or could have played in the first 2 rounds of the tournament. We then observe the confidence intervals of each team and conduct a hypothesis test by incorporating the Bonferroni correction to control for a familywise error. We are able to determine from the pair of rival teams to see who is a strong opponent. By analyzing the statistics, the study further aims to determine whether or not the collegiate team ranking process is fair.

Methodology

The primary dataset for this analysis was from the NCAA women's basketball game results from the 2024-2025 season, where it provides the home wins for each college team. The dataset includes all Division I plays during the season with information about which teams played, scores, and the dates of the game. I made sure the data variables were converted to Date class objects to analyze time.

The variables used in the study are the date of the game, home win (game outcomes: a 1 indicating a win and a 0 indicating a loss), and the names of the college teams that participated in the NCAA women's tournament. In this study, four logistic regression Bradley-Terry models provided an analysis of the NCAA women's basketball team performances, considering different factors such as game location and temporal dynamics that may have influenced the performance of the game. It helps rank teams by looking at the team's strengths using a parameter based on all game outcomes rather than simple win-loss records. The parameter B indicates the team's

strength based on observed tournament results. It allows us to find the probability of one team winning over another based on their performance. The home win variable is binary indicating whether or not the team won the game, 0 indicating a loss and a 1 indicating a win.

The Bradley-Terry model in this case treats the outcome as an independent Bernoulli random variable that is identically distributed, and that each team's strength remains constant across the games in a logistic regression model. It also helps assign scores for a pairwise comparison of the teams, and when we incorporate the home-court advantage it allows us to see whether or not there are other factors that may influence the ranking of the NCAA women's basketball team.

In model 1, the plain Bradley-Terry model helps estimate the teams' strengths through maximum likelihood, using Abilene Christian University's team as the reference team. All other teams' performances are interpreted relative to the reference team and assumes that each team is winning equally with no other factors influencing the results. In model 2, I tried to address the issues of overfitting by using a penalized logistic regression model to strengthen the parameters, preventing extreme estimates. In model 3, we incorporate a home-court advantage parameter. Model 4 allows the team strengths to improve or decline as the season progresses. AIC (Akaike Information Criterion) was used to evaluate all four models' performance, where lower values indicate a better fit. Including the date of the games helps keep track of how teams' strengths evolve over the course of 2024-2025 season. We can see if the teams improved or declined over time. Using the preferred model, I ranked all teams based on their performance, focusing on the

top 10 and bottom 5 teams from their scores (coefficients). Lastly, I calculated Michigan's win probabilities against three possible opponents (Georgia, Ohio State, and Michigan State University) by finding the standard error from the variance-covariance matrix, providing insights about the team strength differences. I then further went in and found out the confidence of the key predictions for the three pairs of teams that we determined by finding the standard error and tested the hypothesis that Michigan was no better than the rival, against the hypothesis that Michigan was the stronger team. A multiplicity correction was incorporated to control the familywise type 1 error rate.

Results

The analysis of NCAA women's basketball teams were formed by creating four Bradley-Terry models to provide key insights about the strengths of all collegiate teams during the 2024-2025 season. In table 1 of this study, I compared the statistic AIC for all four models to see which best captured the performance of the NCAA women's basketball teams.

Models	AIC
Model 1 (no intercept)	5053.3
Model 2 (penalized fitting)	5109.7
Model 3 (home-court)	5052.4
Model 4 (temporal analysis)	5053.3

Table 1: Comparison of Bradley-Terry Models Using AIC Scores

We see that model 3 with the home-court advantage parameter is the preferred model with the lowest AIC value of 5052.4, meaning that home-court advantage significantly improved the ability to predict the outcomes and outperformed compared to the other models. Model 2 has

the highest AIC of 5109.7, suggesting that penalized fitting did not improve the model as much.

We then also ranked the teams (top 10 and bottom 5) based on model 3. The team coefficients reflect their score against a given team. A positive coefficient means that the home team is more likely to win, while a negative coefficient means that the home team is less likely to win. A higher value means that the team is stronger, vice versa. We see that the top 10 teams ranked in order are UCLA, South Carolina, Texas, USC, UConn, TCU, Notre Dame, LSU, Duke, and North Carolina State based on the coefficient. While the bottom 5 teams are Faulkner, Arkansas Baptist, Virginia Lynchburg, Warren Wilson, Cheyney, and Georgian Court University based on the coefficient.

Teams	Michigan's odds against the teams
Michigan vs. Georgia	0.863
Michigan vs. Ohio State	0.813
Michigan vs. Michigan State	0.722

Table 2: Estimated Probabilities of Michigan Winning Against Rivals

Based on the rankings by model 3, we looked at Michigan's odds of winning against three potential teams it could have faced in the first two rounds of the tournament by calculating the standard error. The results are presented in table 2: Michigan having a 86.3% chance of winning against Georgia in the first 2 rounds of the tournament, 81.3% chance of winning against Ohio State, and a 72.1% chance of winning against Michigan State. From these results, we can see that Michigan State is a strong competitor against Michigan compared to the other

two universities based on model 3's ranking.

Rivals	Log Odds Difference	Standard Error	Z-statistic	Raw P-value	Adjusted P-value
Michigan vs. Georgia	3.789521	0.8631619	4.390279	5.660263e-06	1.698079e-05
Michigan vs. Ohio State	-0.6396319	0.8128719	-0.7868792	0.7843237	1
Michigan vs. Michigan State	0.3484379	0.7214677	0.482957	0.3145631	0.9436894

Table 3: Hypothesis Test Results for Michigan and Rivals- The Stronger Opponent

For each of Michigan's rival teams, we tested if there was a statistically significant difference in team strength. The null hypothesis is that there is no difference in team strength vs. the alternative hypothesis being that Michigan was stronger. A Bonferroni correction ($\alpha = 0.05/3$), was incorporated to ensure familywise error control and to compare the teams fairly. Table 3 summarizes the results of the hypothesis test along with the p-values to show whether or not there was a statistically significant difference in team strength. We see that overall Michigan is a pretty strong opponent, but between Michigan vs. Ohio State and Michigan State, Michigan is not that strong of an opponent compared to the other teams besides Georgia.

Discussion

The NCAA women's basketball tournament ranks the 68 teams, but there are some questions about whether or not these rankings reflect the true performances of the women collegiate basketball teams. We want to see whether or not factors such as home-court advantage

affects the rankings by creating four Bradley-Terry models: a plain model, a penalized logistic regression, model that incorporates home-court, and a model that sees the temporal analysis. We look at the statistics to determine which model performs well. Some limitations is that model 2 attempts to prevent overfitting, however we see that it fails to capture the important insights in the data. In model 3, it shows that home advantage is constant across all teams and games. For model 4, where time is being analyzed, it seems to not fully reflect the team's current strength. In the study, the results show that the home-court advantage plays a crucial role in the team rankings and performance. We utilized data from the NCAA women's basketball data to create the ranking of teams and to compute the odds of Michigan winning against three opponents using the chosen model based on which one has the lower AIC. Based on the results, we see that home-court advantage plays a role in the team rankings. While home-court advantage does play a role, we also have to consider that some teams played at home more often than others, which means that there could be slight bias, so we are not able to fully trust the coefficients of the model for those teams, so we may need to conduct further hypothesis testing like we did to ensure that the results are fair. In the future, sports analytics could factor in variables such as home-court advantages in order to create a fair ranking for the NCAA women's basketball teams.