Ranking League of Legends Team Compositions

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1 Introduction

League of Legends (LoL) is a multiplayer online battle arena game where two teams, typically composed of 5 players each, attempt to destroy the enemy team's Nexus, a structure located in the heart of the base and protected by other defensive towers. Players pick from over 140 characters (known as "champions"). Each champion is assigned one of seven classes[a], which are groups of champions with similar styles. For example, tanks excel in soaking up damage from the enemy team more than being significant damage threats, while slayers are fragile but damage focused champions that look to swiftly take down an enemy.

One important aspect of the game is the team's champion composition. In general, a better team composition consists of champions of different classes, instead of a team of five tanks or five slayers. Professional teams consist of coaches and analysts who help with the development of team compositions; this process requires intense preparation and a detailed analysis of the opposing team. Often times, professional games are swayed heavily in favor for one team simply because their team composition synergizes better or has more teamfighting advantages than that of the enemy team.

However, in a normal ranked solo-queue[b] game, teams generally consist of random players with limited in-game communication. Without reliable methods to discuss team compositions[1], solo-queue players, like myself, may benefit from a team composition ranking system, where a higher ranking indicates that forming a specific team composition may result in a higher chance of winning. This ranking system will be modeled using the Bradley-Terry model [1]. Although the Bradley-Terry model is generally used to predict the outcome of a paired comparison, the pairwise rankings can be combined to derive a full ranking. For computation purposes, I will reduce the Bradley-Terry model into a hierarchical logistic regression model and fit it in the Bayesian framework.

The project examines the following questions: 1) How can solo-queue players determine the best classes of champions to play to form a strong team composition? and 2) Which player-level statistics are the most significant features when determining a team composition's overall rank?

2 Literature Review

The Bradley-Terry model [1] has numerous applications. In the Bayesian setting, a generalized version that allows for ties in pairwise comparison was used to rate chess players [2], and a hierarchical version was used to rank MLB teams [3]. The model has also been applied to LoL data but was used to predict match results [4], rather than to provide team composition rankings.

[1] Team composition in this paper refers to the classes associated with the 5 champions on a team, rather than the names of the champions themselves.

3 Data

The original data includes 108,829 games in Korean solo-queue played in Master tier or higher played during Seasons 8-10, which were from 2018-2020. I downloaded the data from Kaggle [5], which was scraped from Riot Games using their API [6]. Each game contains information about each of the 10 players and numeric attributes about each player's performance. However, there are many inconsistencies with the players' recorded roles[c] in original dataset, which are discussed further in the Appendix in Section 8.3. After removing these inconsistencies, there were 31,909 games and 382 unique team compositions.

Table 1: Description of Raw Variables (** Indicates Variable was Mean-Centered and Standardized)

Variable	Description	Values
Response		
win (N = 31,909)	Outcome of a Game	0 (No), 1 (Yes)
Predictors		
championPoints (CP)** (N = 319,090)	Amount of Experience a Player has with a Champion	-0.48 to 13.59
totalChampionMasteryScore (MS)** (N = 319,090)	Total Sum of a Player's championPoints	-1.87 to 3.94
lastPlayTime** (N = 319,090)	Last Time a Player Played a Champion	-12.68 to 0.6

For each game, there are player-level variables for each of the 10 players, for a total of 319,010 observations per variable. The three player-level variables were chosen based on domain-driven knowledge; they are displayed in Table 1. *championPoints* are accrued for each champion that a player has played, so a higher value indicates that a player has more experience with a specific champion. Each player will thus have a *championPoints* value for each champion they haved played, so *totalChampionMasteryScore* is the sum of a player's *championPoints* values. *lastPlayTime* is a timestamp that indicates the last time a player played a specific champion. *championPoints*, *totalChampionMasteryScore* and *lastPlayTime* were all mean-centered and standardized.

Table 2: Description of Transformed Variables

Variable	Description	Values
Predictors		
Δ_{ijk}CP (N = 31,909)	Difference between the aggregate champion points for the 5 players on team i and that of team j in game k	-15.42 to 16.92
Δ_{ijk}MS (N = 31,909)	Difference between the aggregate mastery score for the 5 players on team i and that of team j in game k	-9.29 to 11.89
Δ_{ijk}lastPlayTime (N = 31,909)	Difference between the aggregate last time played for the 5 players on team i and that of team j in game k	-21.9 to 21.52

These three player-level variables had to be transformed before they can be incorporated in the model. In each game $k \in (1,\ 2,\ \ldots,\ 31909)$, $\Delta_{ijk}CP$ is the difference between the aggregate champion points

for the 5 players on team i and that of team j. This is done for both $\Delta_{ijk}MS$ and $\Delta_{ijk}lastPlayTime$ as well. The values for these transformed variables are shown in Table 2.

3.1 EDA

Figure 1 displays the distribution of win percentages across the different team compositions. Barring team compositions that have a 0% or 100% win rate, the win percentages are approximately normally distributed, with most teams having a win percentage of around 50%. The team compositions that have a 0% or 100% win rate are recorded either once or twice, which indicate that the rankings for these teams may have more variability and is one limitation with the dataset.

Figure 2 displays the relationship between $\Delta_{ijk}CP$ and $\Delta_{ijk}MS$ for the 382 different team compositions. The figure shows that for certain team compositions, there is a direct relationship between $\Delta_{ijk}CP$ and $\Delta_{ijk}MS$ (indicated by lines with a positive slope), and an inverse relationship for other team compositions (indicated by lines with a negative slope). This supports evidence for an interaction term between these two variables in the model.

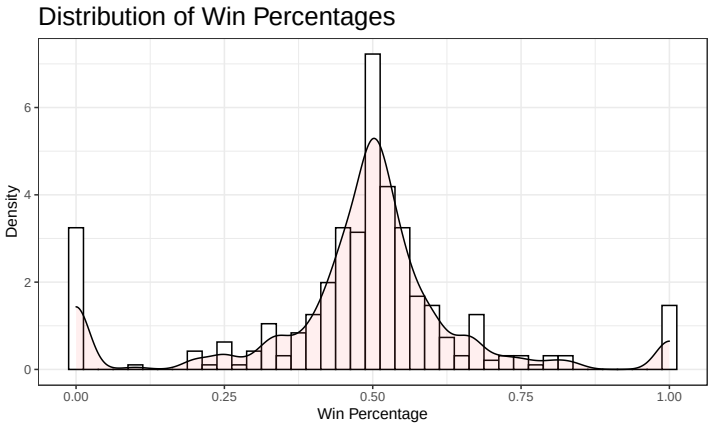

Figure 1

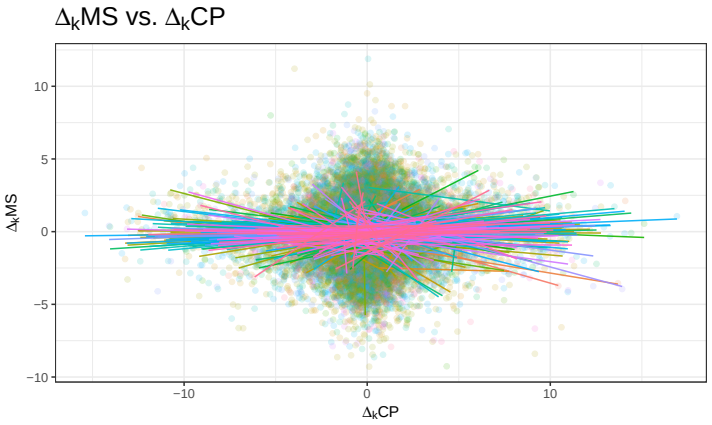

Figure 2

4 Methodology

For two team compositions i and j, Bradley and Terry [1] suggested the following model:

$$Pr(i \text{ beats } j) = \text{logit}^{-1}(\lambda_i - \lambda_j), \quad (1)$$
$$\text{logit}[Pr(i \text{ beats } j)] = \lambda_i - \lambda_j, \quad (2)$$

where $\text{logit}^{-1}(\nu) = \frac{exp(\nu)}{1+exp(\nu)}$ and $\lambda_i \in \mathbb{R}$ represents a team composition's "strength" - a larger value of λ_i indicates a higher ranking. In (2), the Bradley-Terry model is reduced to a logistic regression on pairs of team compositions. Since the pairwise rankings can be combined, an overall ranking of team compositions $i \in (1 \dots 382)$ can be determined with a logistic regression model. In addition, this methodology allows for the incorporation of player-level effects. Thus, I fit a hierarchical Bayesian logistic regression model to determine the ranking for all 382 team compositions. The Bayesian framework was selected since it may provide better convergence of estimates and more realistic rankings for the team compositions with 0% or 100% win rate - a frequentist logistic model would rank the team compositions by descending win rate.

$$Y_{ijk} \sim Bernoulli(\pi_{ijk})$$
$$log\left(\frac{\pi_{ijk}}{1-\pi_{ijk}}\right) = \lambda_i - \lambda_j + \beta_1 * \Delta_{ijk}CP + \beta_2 * \Delta_{ijk}MS + \beta_3 * \Delta_{ijk}lastPlayTime + \beta_4 * (\Delta_{ijk}CP * \Delta_{ijk}MS) \quad (3)$$
$$\lambda_i \sim N(0, \sigma^2_{comp}),\ \sigma^2_{comp} \sim Ga(1,1)$$
$$\beta_1,\ \beta_2,\ \beta_3,\ \beta_4 \sim N(0, 10)$$

The final model is shown in (3). Y_{ijk} is the outcome of the game when team composition i plays team composition j in game $k \in (1,\ 2,\ \ldots,\ 31,909)$, where $Y_{ijk} = 1$ indicates that team i won. π_{ijk} is the probability that i beats j in game k. λ_i and λ_j represent the strength of teams i and j - as a reminder, a higher λ value indicates a higher ranking. Each λ_i is sampled from a normal distribution centered at 0, with variance σ^2_{comp} - this allows for the implementation of a hierarchical component to account for differences among each team composition. In addition, the three player-level variables, and an interaction, are included in the model since a team's overall strength or ranking can be thought of as "the sum of its parts." Uninformative, flat priors are placed on the β coefficients, since there is no prior knowledge on what these coefficients should be.

Variable selection was performed by trying different combinations of interaction terms - the three player-level variables were always kept in the model. Insignificant interaction terms were then removed. Posterior predictive checks (simulating game outcomes) were also analyzed for each model. The final model (3) produced the best simulated game outcomes, although all 6 models that I tested produced similar estimates and simulated game outcomes.

5 Results

5.1 Ranking System

Table 3: Top 10 Team Compositions by Strength, $\hat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
1	89	Controller, Fighter, Marksman, Slayer, Specialist	0.139	(0.035, 0.243)	55.12
2	60	Controller, Fighter, Fighter, Marksman, Slayer	0.110	(0.036, 0.188)	52.09
3	264	Fighter, Marksman, Slayer, Tank, Tank	0.107	(0.005, 0.225)	54.64
4	18	Controller, Controller, Fighter, Marksman, Slayer	0.079	(-0.053, 0.242)	58.96
5	75	Controller, Fighter, Mage, Marksman, Slayer	0.077	(0.011, 0.147)	50.73
6	263	Fighter, Marksman, Slayer, Specialist, Tank	0.077	(-0.027, 0.182)	52.83
7	241	Fighter, Mage, Slayer, Slayer, Tank	0.071	(-0.059, 0.246)	64.29
8	297	Mage, Mage, Marksman, Slayer, Tank	0.070	(-0.055, 0.217)	55.33
9	146	Controller, Marksman, Slayer, Slayer, Tank	0.069	(-0.046, 0.197)	53.51
10	90	Controller, Fighter, Marksman, Slayer, Tank	0.069	(-0.015, 0.155)	51.65

Table 3 displays the top 10 team compositions, ranked by descending strength (λ_i) - a full ranking is in the Appendix. From the λ_i values of these teams, the best team, composition 89, is relatively clear.

Its strength value of 0.139 is slightly higher than that of any other top 10 team. However, for these 10 teams, it can be hard to differentiate between the strengths between these teams - these values are relatively small and close to each other. Table 4 displays the weakest 10 team compositions. Similarly, their strength values are also relatively similar, with the exception of the last place team, composition 215, whos strength value is much lower than that of the other bottom tier teams.

Table 4: Bottom 10 Team Compositions by Strength, $\hat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
373	254	Fighter, Marksman, Marksman, Slayer, Specialist	-0.043	(-0.177, 0.088)	44.00
374	59	Controller, Fighter, Fighter, Marksman, Marksman	-0.048	(-0.173, 0.079)	44.53
375	261	Fighter, Marksman, Slayer, Slayer, Tank	-0.048	(-0.146, 0.046)	46.79
376	167	Fighter, Fighter, Fighter, Mage, Marksman	-0.048	(-0.167, 0.066)	45.63
377	230	Fighter, Mage, Marksman, Marksman, Slayer	-0.048	(-0.156, 0.058)	46.23
378	229	Fighter, Mage, Marksman, Marksman, Marksman	-0.048	(-0.213, 0.089)	35.21
379	253	Fighter, Marksman, Marksman, Slayer, Slayer	-0.053	(-0.191, 0.07)	43.85
380	196	Fighter, Fighter, Marksman, Marksman, Slayer	-0.064	(-0.187, 0.046)	43.85
381	220	Fighter, Mage, Mage, Marksman, Slayer	-0.065	(-0.181, 0.028)	45.68
382	215	Fighter, Mage, Mage, Mage, Marksman	-0.104	(-0.278, 0.033)	34.57

Ultimately, it is hard to distinguish a team composition that is much stronger than the other ones, since the strength values are relatively close across all 382 team compositions. This is highlighted in Figure 3, where the posterior densities of λ_i are plotted for the top 5 and bottom 5 teams. We see that the posterior distributions largely overlap. This is mainly because most teams have a win rate of around 50%. Although the model includes a hierarchical component and incorporates player-level statistics, it can struggle to extract significant differences between these team compositions since so many of them have similar win rates.

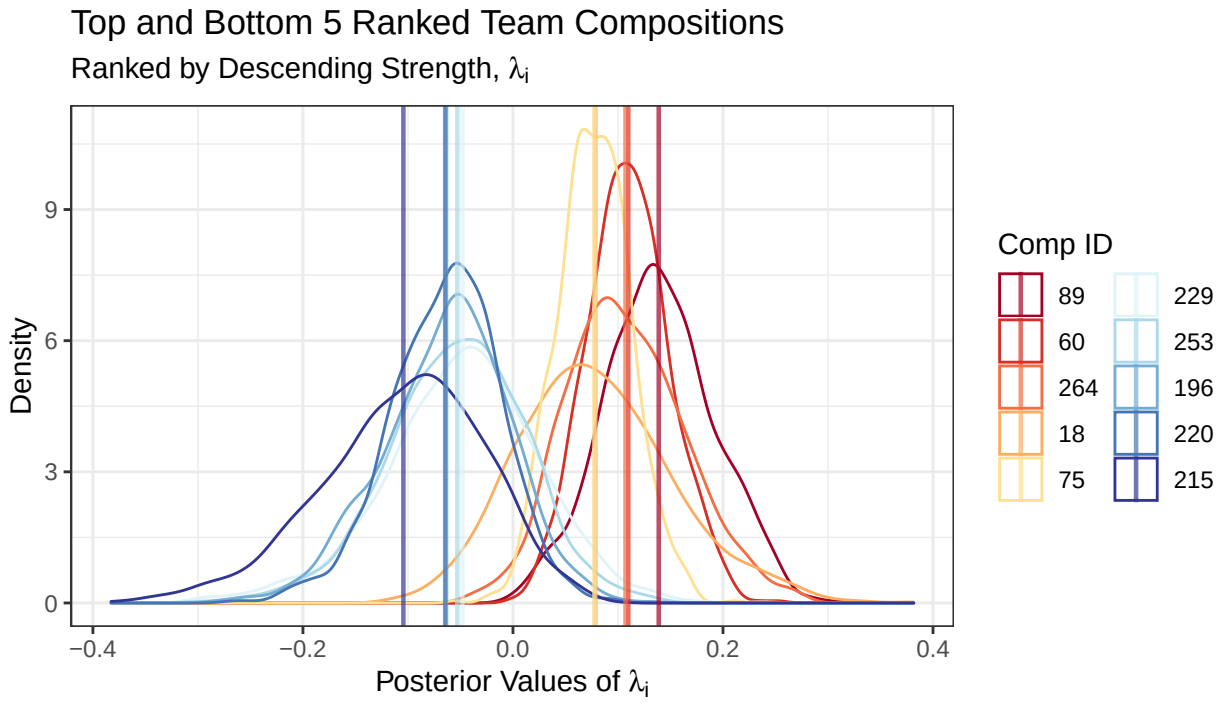

Figure 3

In general, a strong team will have a balance between offensive and defensive champions. There are a

total of 268 team compositions that contain at least one defensive champion (Controller or Tank). The top 20 ranked team compositions all have balanced compositions - that is, all have at least one defensive champion. These defensive champions give a team composition more viability during the game - during team fights, Controllers can heal or strengthen teammates while Tanks can soak up damage from the enemy team to protect its team.

However, not all balanced compositions are ranked highly. There are 2 teams in the bottom 10 that also have at least one defensive champion (compositions 59 and 261). This could be due to a multitude of reasons. Recall that a team composition's strength is not solely determined by the 5 champion classes or its win rate - the player-level variables also affect a team composition's final ranking. The players on these teams could have been weaker or less experienced than their opponents, which would contribute to these team compositions' low rankings.

In terms of team compositions with all offensive champions (no Controller or Tank), the highest is ranked 22nd (team composition 219), while 8 of the bottom 10 consist of team compositions with 5 offensive champions. This further suggests that a balanced team composition will perform better than one that is unbalanced.

5.2 Significant Player-level Predictors

Table 5 displays the exponentiated coefficient values for the 3 player-level variables, $\Delta_{ijk}CP$, $\Delta_{ijk}MS$ and $\Delta_{ijk}lastPlayTime$, as well as the interaction between $\Delta_{ijk}CP$ and $\Delta_{ijk}MS$. We see that all coefficients, except for $\Delta_{ijk}lastPlayTime$, are significant features when determining a team composition's overall rank. Thus, for every increase in the difference in total champion points from team i to that of team j, we expect the odds of winning the game to multiply by a factor of 1.024 (1.013, 1.035), while for every increase in the difference in total mastery score from team i to that of team j, we expect the odds of winning the game to multiply by a factor of 0.983 (0.971, 0.996).

The first takeaway is as expected. If team i consists of players that have more experience playing their 5 champions than the players on team j, we expect team i to have a slightly higher chance of winning. However, the second takeaway may be surprising at first, but is also expected. Recall that *totalChampionMasteryScore* is the sum of a player's *championPoints*. For example, consider hypothetical player X, who has played champions Lee Sin, Zac, and Graves. Player X has played Lee Sin and Zac extensively, but has rarely played Graves. Player X will have a high *totalChampionMasteryScore* and *championPoints* for Lee Sin and Zac, but a low *championPoints* for Graves. In game k, Player X, who is on team i, decides to play Graves. Assume that because of Player X's experience playing Lee Sin and Zac, team i's aggregate *totalChampionMasteryScore* is much higher than that of their oppponent, team j. However, team i may be more likely to lose the game simply because Player X is not an experienced Graves player.

Table 5: Coefficients for Player-Level Variables from (3)

Parameter	Estimate	95% CI
Δ_{ijk}CP	1.024	(1.013, 1.035)
$\Delta_{ijk}MS$	0.983	(0.971, 0.996)
$\Delta_{ijk}lastPlayTime$	1.003	(0.992, 1.014)
$\Delta_{ijk}CP$ * $\Delta_{ijk}MS$	1.016	(1.01, 1.022)

These results suggest that more overall experience playing the game (a higher *totalChampionMas-*

teryScore) is **not** as important as gaining experience playing specific champions (a higher *championPoints*). Thus solo-queue players may have a higher chance of winning when playing champions they have more experience with.

5.3 Model Diagnostics

Figures 4 and 5 in the Appendix display traceplots for the top four λ_i's (team compositions 89, 60, 264, and 18) and the β's.The quantiles for $\hat{R}$ values are shown in Table 6 in the Appendix. The traceplots indicate the chains have mixed well and $\hat{R}$ values close to 1, indicating that our model generated from (3) has sufficiently converged.

5.3.1 Sensitivity Analysis

I display the top 10 team compositions and their estimated strength values (λ_i) across different prior distributions on σ^2_{comp}. Across the three priors, we see that the estimated $lambda_i$ values for the top 10 teams are relatively consistent and that the top three teams (89, 60 and 264) are the same. The top 10 teams estimated by the $Ga(0.1, 1)$ prior on σ^2_{comp} are the same as those from (3), except it orders the teams ranked 4-10 slightly differently. The top 10 team compositions estimated by the $Ga(2, 1)$ prior on σ^2_{comp} includes 8 of the same team compositions estimated by the two previous priors, with the addition of compositions 90 and 297, instead of 8 and 76 in its top 10. Thus, the results are relatively insensitive to prior choice since there are no drastic discrepancies across different priors [7].

Table 6: Top 10 Team Compositions by Strength, $\hat{\lambda}_i$, from Different Priors on σ^2_{comp}

	Ga(1, 1)		Ga(0.1, 1)		Ga(2, 1)	
	Comp ID	Strength	Comp ID	Strength	Comp ID	Strength
1	89	0.139	89	0.141	89	0.143
2	60	0.110	60	0.110	60	0.115
3	264	0.107	264	0.106	264	0.112
4	18	0.079	75	0.081	75	0.083
5	75	0.077	263	0.077	18	0.077
6	263	0.077	18	0.076	263	0.076
7	241	0.071	297	0.073	241	0.076
8	297	0.070	241	0.071	146	0.073
9	146	0.069	90	0.069	76	0.072
10	90	0.069	146	0.068	8	0.071

5.4 Validation

5.4.1 Cross Validation

To check the validity of (3), I compute an approximate LOOCV using `PSIS-LOO` [8]. The printed output in Table 7 shows the estimates $\widehat{elpd}_{loo}$ (expected log predictive density), $\hat{p}_{loo}$ (effective number of parameters), and $-2\widehat{elpd}_{loo}$ (the LOO information criterion). In addition, the output states that all Pareto k

estimates are good ($k < 0.5$) - the interpretation of k can be found in greater detail in Vehtari, Simpson, Gelman, Yao, and Gabry [8]. This output indicates that all the estimates for k are fine, thus providing an initial validation for this model.

Table 7: Using Efficient PSIS-Loo Approximation to Exact LOOCV

Estimates	Estimate	SE
Expected Log Predictive Density (epld)	-265.672	0.869
Effective Number of Parameters (p)	0.546	0.012
LOO Information Criterion (looic)	531.345	1.739

Note:
All Pareto k estimates are good (k < 0.5)

5.4.2 Simulating Game Outcomes

As another form of validation, I simulate game outcomes using the λ_i's and β's that were generated from (3) and then compare them to the actual outcomes. To simulate the game outcomes, I first calculate π_{ij}, the overall probability that team i beats team j. From (3), we know that

$$log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \lambda_i - \lambda_j + \sum_{p=1}^{4}\beta_p \quad (4)$$

$$\pi_{ij} = \frac{e^{\lambda_i - \lambda_j + \sum_{p=1}^{4}\beta_p}}{1 + e^{\lambda_i - \lambda_j + \sum_{p=1}^{4}\beta_p}} \quad (5)$$

Then we take the probability obtained in (5) and sample 100,000 game outcomes from a Bernoulli distribution.

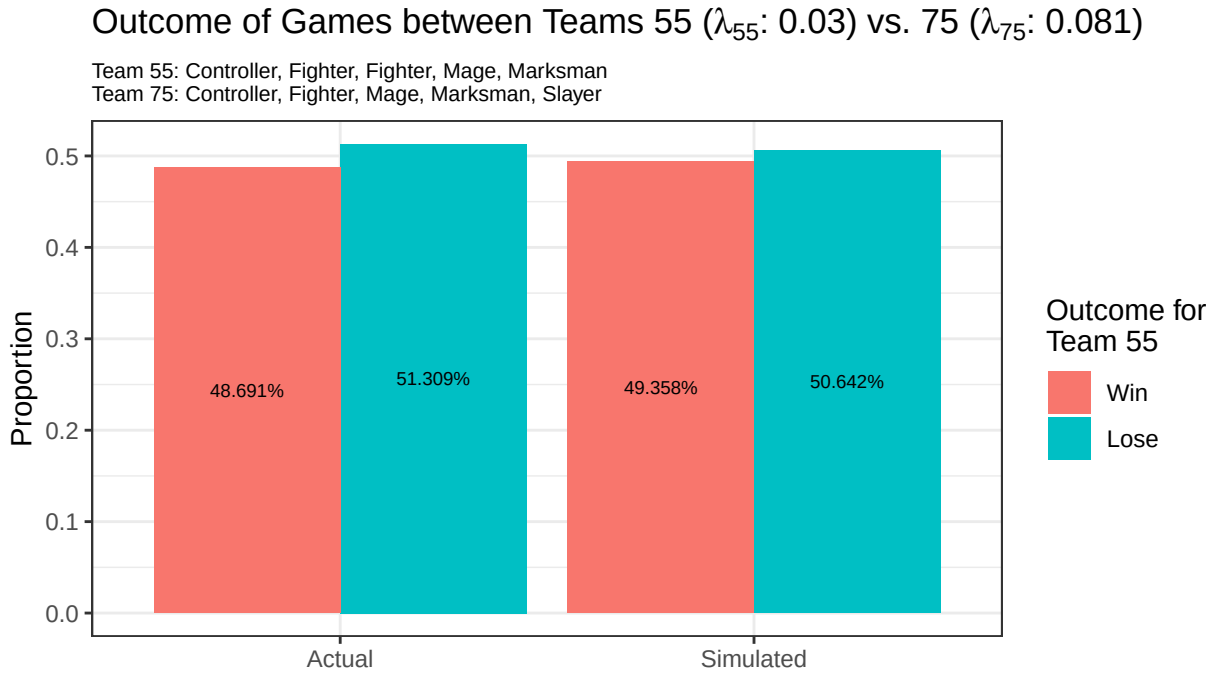

Figure 7

Figure 7 displays the actual and simulated outcomes of games between team composition 55 vs. 75. These two team compositions are the most played: team 55 has been played 4,214 times while team 75 has been played 3,420 times. These two teams also have the most head to head games, 191. Out of these 191 games, team composition 55 won 93, or 48.691%, of its games. The estimated value of $\pi_{(55,75)}$ is 0.494. From 100,000 simulated games, team composition 55 won 49.358% of its games. The proportions of the actual and simulated game outcomes are very similar - this indicates that our model performs well for matchups that have occured multiple times in the dataset.

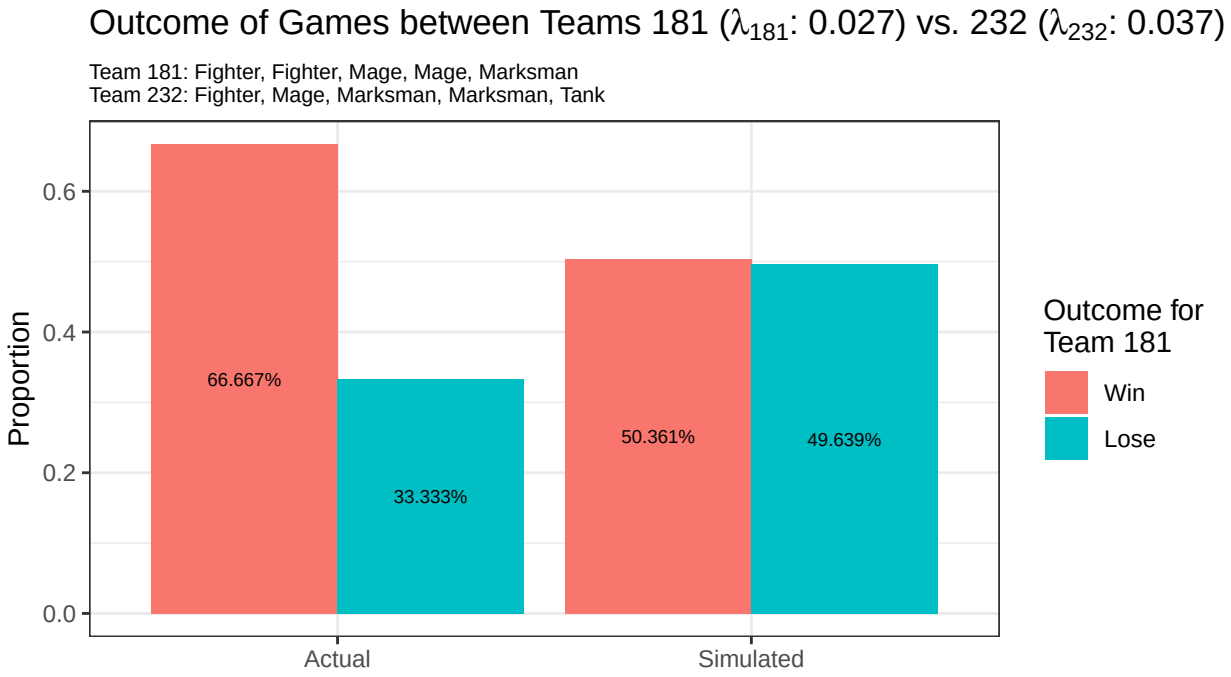

Figure 8

Figure 8 displays the actual and simulated outcomes of games between team composition 181 vs. 232. These two team compositions are not as commonly played - they only have 9 head to head matches. Out of these 9 games, team composition 181 won 6, or 66.667%, of its games. The estimated value of $\pi_{(181,232)}$ is 0.504. From 100,000 simulated games, team composition 181 won 50.361% of its games. The proportions of the actual and simulated game outcomes are not similar for this situation - this is primarily due to the small number of actual head to head games between these two teams. This indicates that the model can struggle to properly estimate the strength (λ_i) of teams that are not commonly played.

6 Discussion

6.1 Selecting which Champion to Play

6.1.1 First Pick

Now I will discuss some interesting applications of this ranking system. In this first application, we assume that you are the first player to pick a champion in a game. The ranking system can be used to determine which champion or champion class maximizes your team's expected composition strength.

Table 8 displays the strength values of the top 20 ranked champions. These strength values were calculated by averaging the λ_i's obtained from (3) for each champion. For example, if champion Z was played on

team compositions 1 and 2, champion Z's strength would be the average of the strengths of compositions 1 and 2.

We see that the top 13 ranked champions are all Controllers - this reinforces the idea that balanced team compositions are generally better than ones with 5 offensive champions. In addition, the lowest ranked Controller (Ivern) is ranked 26th. However, Controllers are generally picked by the Support player, who is not always the first one to select their champion. The next best classes of champions are Slayers and Marksman - these two classes of champions can be played in almost any role[c] (Top, Jungle, Mid, Bottom or Support). Thus, regardless of the role of the first pick player, they have a wide pool of viable champions and 2-3 strong champion classes to pick from.

Table 8: Top 20 Champions, determined by averaging λ_i's from (3)

	Champion Name	Class	Strength	95% CI
1	Bard	Controller	0.048	(-0.044, 0.145)
2	Janna	Controller	0.048	(-0.045, 0.146)
3	Thresh	Controller	0.048	(-0.044, 0.144)
4	Blitzcrank	Controller	0.047	(-0.047, 0.144)
5	Rakan	Controller	0.047	(-0.046, 0.144)
6	Morgana	Controller	0.046	(-0.049, 0.145)
7	Nami	Controller	0.046	(-0.048, 0.145)
8	Zyra	Controller	0.046	(-0.05, 0.146)
9	Lulu	Controller	0.045	(-0.054, 0.15)
10	Taric	Controller	0.045	(-0.053, 0.147)
11	Yuumi	Controller	0.045	(-0.048, 0.143)
12	Soraka	Controller	0.041	(-0.061, 0.149)
13	Sona	Controller	0.040	(-0.065, 0.15)
14	Fizz	Slayer	0.039	(-0.061, 0.141)
15	Kassadin	Slayer	0.037	(-0.064, 0.14)
16	Kog'Maw	Marksman	0.036	(-0.06, 0.135)
17	Diana	Slayer	0.035	(-0.067, 0.139)
18	Xayah	Marksman	0.035	(-0.061, 0.135)
19	Katarina	Slayer	0.034	(-0.068, 0.138)
20	Talon	Slayer	0.034	(-0.071, 0.142)

6.1.2 Last Pick

Now, we assume that you are the last player on your team to pick a champion. Once again, we want to determine which classes of champions would maximize your team's expected strength. For this application, I will pick two different sets of four champion classes, and determine the optimal last pick. The first set is Fighter, Mage, Slayer and Tank. Table 9 displays the rankings of the 7 different team compositions that contain this set of four champions. As last pick, the optimal champion class would be a Slayer - this combination of champion classes are ranked the highest, with a strength (λ_i) value of 0.071. The next best champion class is a Controller, which is not surprising. From Table 8, we see that Controllers are some of the highest ranked champions. One reason why a last pick Controller may not be the best option is that the team already has a defensive champion (a Tank). The lowest ranked last pick is a

Table 9: Set of 4 Champion Classes: Fighter, Mage, Slayer and Tank

Overall Rank	Composition	Potential Last Pick	Strength	95% CI
7	Fighter, Mage, Slayer, Slayer, Tank	Slayer	0.071	(-0.059, 0.246)
23	Controller, Fighter, Mage, Slayer, Tank	Controller	0.042	(-0.08, 0.177)
35	Fighter, Mage, Marksman, Slayer, Tank	Marksman	0.032	(-0.034, 0.105)
71	Fighter, Mage, Slayer, Specialist, Tank	Specialist	0.019	(-0.12, 0.162)
129	Fighter, Fighter, Mage, Slayer, Tank	Fighter	0.007	(-0.132, 0.142)
360	Fighter, Mage, Mage, Slayer, Tank	Mage	-0.028	(-0.167, 0.102)
365	Fighter, Mage, Slayer, Tank, Tank	Tank	-0.032	(-0.173, 0.12)

Tank - this suggests that the player picking last should not pick a Tank. This could be due to the lack of offensive power with two defensive and low damage champions or the model's struggles to distinguish between team compositions due to many team compositions having an approximately 50% win rate.

Table 10: Set of 4 Champion Classes: Controller, Fighter, Marksman and Slayer

Overall Rank	Composition	Potential Last Pick	Strength	95% CI
1	Controller, Fighter, Marksman, Slayer, Specialist	Specialist	0.139	(0.035, 0.243)
2	Controller, Fighter, Fighter, Marksman, Slayer	Fighter	0.110	(0.036, 0.188)
4	Controller, Controller, Fighter, Marksman, Slayer	Controller	0.079	(-0.053, 0.242)
5	Controller, Fighter, Mage, Marksman, Slayer	Mage	0.077	(0.011, 0.147)
10	Controller, Fighter, Marksman, Slayer, Tank	Tank	0.069	(-0.015, 0.155)
30	Controller, Fighter, Marksman, Slayer, Slayer	Slayer	0.037	(-0.049, 0.122)
322	Controller, Fighter, Marksman, Marksman, Slayer	Marksman	-0.012	(-0.114, 0.096)

The second set of four champions is Controller, Fighter, Marksman and Slayer. Table 10 displays the rankings of the 7 different team compositions that contain this set of four champions. As last pick, the best two classes to select would be a Specialist and Fighter - these also correspond with the top 2 ranked team compositions. A last pick Controller or Mage also creates strong teams, but their strength (λ_i) are slightly lower than that of the top 2 picks. The worst last pick, a Marksman, is ranked 322nd overall. This could be because double Marksman compositions are hard to execute, and solo-queue players may not have enough synergy or communication to execute this type of composition.

7 Conclusion & Limitations

This paper utilized a hierarchical Bayesian logistic regression model (a reduction of the Bradley-Terry model) to form a team composition ranking system. It also provides an insight into which player-level statistics are the most significant features when determining a team composition's overall rank.

The major limitation from this analysis is the lack of data for certain team compositions. There are a handful of team compositions that are recorded only once or twice - these compositions end up having eiter 0% or 100% win rates. However, this is highly unlikely in solo-queue. In addition, with the majority of teams having an approximately 50% win rate, the model struggles to distinguish between team compositions. This could be a reason why the strength (λ_i) values are relatively small and close to each other.

Further work includes examining other formations of team compositions (potentially by champion name instead of champion class) and the inclusion of more player-level variables.

8 Appendix

8.1 References

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8.2 Terminology

a). **Class** - One of seven classes assigned to champions that play similar styles. The five offensive classes are Fighters, Mages, Marksman, Slayers and Specialists. The two defensive classes are Controllers and Tanks.

b). **Solo-queue** - Whenever a person or a group of people queue up for the game. Solo-queue generally refers to ranked games. Playing ranked games will determine a player's Elo, which will rise and fall based on their overall win ratio.

c). **Champion Role** - Top, Jungle, Middle, Bottom, or Support, where the Bottom and Support play in the Bottom lane. Players will indicate their preferred role before the match-making system puts them in a game.

8.3 Inconsistencies with Data

Teams consist of 5 players, each with a unique role - Top, Jungle, Mid, Bot, and Support. There are games where players' roles were either missing or recorded as *none*. In addition, Bot laners were initially labeled as one of three categories: *duo_carry*, *duo_support* and *duo*. The first two refer to the Bot and Support roles respectively, while *duo* does not clearly differentiate between Bot and Support. I decided not to impute any missing or inconsistent data. Since champions can hypothetically be played in any role, imputation may not take that into consideration and could bring unwanted variability to the results. Thus, I removed games where any player's role is missing or recorded as *none* or *duo*. This process results in the final dataset, which contains 31,909 games.

8.4 Full Team Composition Rankings

8.5 Model Diagnostics

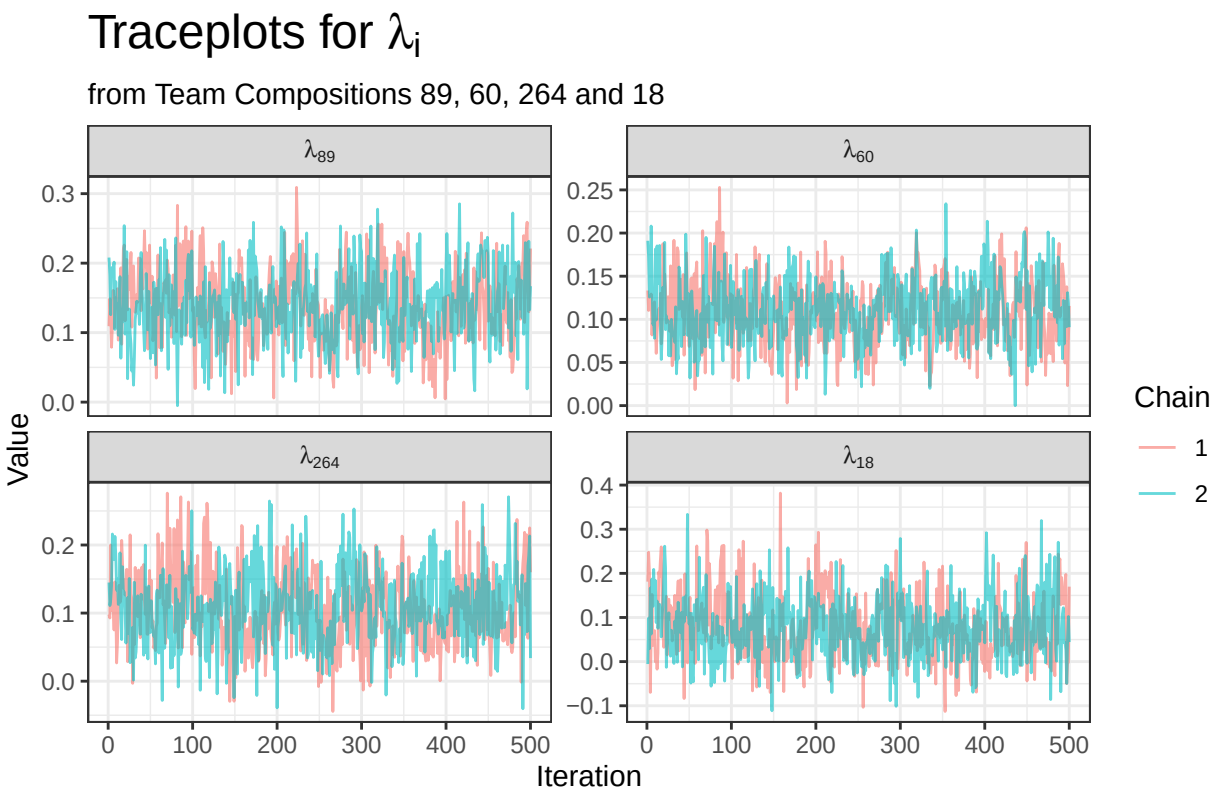

Figure 4

Table 11: Team Compositions Ranked by Strength, $\widehat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
1	89	Controller, Fighter, Marksman, Slayer, Specialist	0.139	(0.035, 0.243)	55.12
2	60	Controller, Fighter, Fighter, Marksman, Slayer	0.110	(0.036, 0.188)	52.09
3	264	Fighter, Marksman, Slayer, Tank, Tank	0.107	(0.005, 0.225)	54.64
4	18	Controller, Controller, Fighter, Marksman, Slayer	0.079	(-0.053, 0.242)	58.96
5	75	Controller, Fighter, Mage, Marksman, Slayer	0.077	(0.011, 0.147)	50.73
6	263	Fighter, Marksman, Slayer, Specialist, Tank	0.077	(-0.027, 0.182)	52.83
7	241	Fighter, Mage, Slayer, Slayer, Tank	0.071	(-0.059, 0.246)	64.29
8	297	Mage, Mage, Marksman, Slayer, Tank	0.070	(-0.055, 0.217)	55.33
9	146	Controller, Marksman, Slayer, Slayer, Tank	0.069	(-0.046, 0.197)	53.51
10	90	Controller, Fighter, Marksman, Slayer, Tank	0.069	(-0.015, 0.155)	51.65
11	76	Controller, Fighter, Mage, Marksman, Specialist	0.066	(-0.015, 0.149)	51.56
12	8	Controller, Controller, Fighter, Fighter, Marksman	0.064	(-0.075, 0.228)	63.33
13	125	Controller, Mage, Marksman, Specialist, Tank	0.063	(-0.063, 0.225)	54.86
14	70	Controller, Fighter, Mage, Mage, Marksman	0.063	(-0.02, 0.15)	51.49
15	121	Controller, Mage, Marksman, Slayer, Slayer	0.061	(-0.055, 0.185)	52.90
16	123	Controller, Mage, Marksman, Slayer, Tank	0.059	(-0.046, 0.166)	52.03
17	108	Controller, Mage, Mage, Marksman, Slayer	0.054	(-0.06, 0.195)	53.50
18	77	Controller, Fighter, Mage, Marksman, Tank	0.053	(-0.022, 0.132)	50.36
19	324	Mage, Marksman, Slayer, Specialist, Tank	0.049	(-0.058, 0.181)	52.42
20	56	Controller, Fighter, Fighter, Mage, Slayer	0.047	(-0.078, 0.18)	55.09
21	294	Mage, Mage, Marksman, Marksman, Tank	0.047	(-0.084, 0.196)	58.18
22	219	Fighter, Mage, Mage, Marksman, Marksman	0.045	(-0.07, 0.179)	53.03
23	80	Controller, Fighter, Mage, Slayer, Tank	0.042	(-0.08, 0.177)	56.64
24	222	Fighter, Mage, Mage, Marksman, Tank	0.042	(-0.047, 0.141)	50.68
25	231	Fighter, Mage, Marksman, Marksman, Specialist	0.040	(-0.091, 0.178)	53.36
26	203	Fighter, Fighter, Marksman, Specialist, Tank	0.039	(-0.086, 0.174)	51.58
27	232	Fighter, Mage, Marksman, Marksman, Tank	0.038	(-0.054, 0.146)	50.99
28	259	Fighter, Marksman, Slayer, Slayer, Slayer	0.037	(-0.096, 0.18)	54.14
29	148	Controller, Marksman, Slayer, Specialist, Tank	0.037	(-0.079, 0.158)	52.62
30	88	Controller, Fighter, Marksman, Slayer, Slayer	0.037	(-0.049, 0.122)	50.68
31	356	Marksman, Marksman, Specialist, Tank, Tank	0.036	(-0.106, 0.184)	64.86
32	322	Mage, Marksman, Slayer, Slayer, Tank	0.035	(-0.073, 0.167)	51.28
33	361	Marksman, Slayer, Slayer, Specialist, Specialist	0.035	(-0.1, 0.192)	66.67
34	145	Controller, Marksman, Slayer, Slayer, Specialist	0.034	(-0.087, 0.158)	52.32
35	235	Fighter, Mage, Marksman, Slayer, Tank	0.032	(-0.034, 0.105)	49.40
36	79	Controller, Fighter, Mage, Slayer, Specialist	0.031	(-0.1, 0.175)	56.38
37	71	Controller, Fighter, Mage, Mage, Slayer	0.031	(-0.111, 0.178)	55.56
38	54	Controller, Fighter, Fighter, Mage, Mage	0.031	(-0.096, 0.188)	53.90
39	92	Controller, Fighter, Marksman, Specialist, Tank	0.030	(-0.085, 0.159)	51.27
40	266	Fighter, Marksman, Specialist, Specialist, Tank	0.030	(-0.108, 0.17)	55.91
41	296	Mage, Mage, Marksman, Slayer, Specialist	0.029	(-0.108, 0.18)	53.54
42	55	Controller, Fighter, Fighter, Mage, Marksman	0.029	(-0.031, 0.09)	48.81
43	38	Controller, Controller, Marksman, Slayer, Specialist	0.029	(-0.115, 0.181)	62.50
44	109	Controller, Mage, Mage, Marksman, Specialist	0.027	(-0.095, 0.168)	53.79
45	188	Fighter, Fighter, Mage, Marksman, Tank	0.027	(-0.044, 0.101)	49.13

Table 12: Team Compositions Ranked by Strength, $\widehat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
46	258	Fighter, Marksman, Marksman, Tank, Tank	0.027	(-0.11, 0.177)	53.23
47	49	Controller, Fighter, Fighter, Fighter, Mage	0.027	(-0.118, 0.184)	57.89
48	321	Mage, Marksman, Slayer, Slayer, Specialist	0.027	(-0.102, 0.167)	53.33
49	72	Controller, Fighter, Mage, Mage, Specialist	0.026	(-0.109, 0.172)	58.82
50	169	Fighter, Fighter, Fighter, Mage, Specialist	0.026	(-0.109, 0.199)	76.47
51	198	Fighter, Fighter, Marksman, Marksman, Tank	0.026	(-0.091, 0.154)	50.86
52	260	Fighter, Marksman, Slayer, Slayer, Specialist	0.025	(-0.094, 0.152)	51.71
53	149	Controller, Marksman, Slayer, Tank, Tank	0.025	(-0.095, 0.167)	52.02
54	335	Mage, Slayer, Slayer, Tank, Tank	0.024	(-0.129, 0.18)	70.83
55	110	Controller, Mage, Mage, Marksman, Tank	0.024	(-0.105, 0.167)	52.48
56	283	Mage, Mage, Mage, Marksman, Slayer	0.024	(-0.116, 0.177)	58.33
57	257	Fighter, Marksman, Marksman, Specialist, Tank	0.024	(-0.106, 0.163)	53.23
58	358	Marksman, Slayer, Slayer, Slayer, Slayer	0.024	(-0.108, 0.173)	61.54
59	147	Controller, Marksman, Slayer, Specialist, Specialist	0.023	(-0.11, 0.166)	54.62
60	122	Controller, Mage, Marksman, Slayer, Specialist	0.023	(-0.086, 0.136)	50.71
61	27	Controller, Controller, Mage, Marksman, Slayer	0.023	(-0.112, 0.182)	54.65
62	285	Mage, Mage, Mage, Marksman, Tank	0.023	(-0.124, 0.166)	56.52
63	300	Mage, Mage, Marksman, Tank, Tank	0.022	(-0.115, 0.171)	54.44
64	323	Mage, Marksman, Slayer, Specialist, Specialist	0.022	(-0.118, 0.167)	54.93
65	181	Fighter, Fighter, Mage, Mage, Marksman	0.021	(-0.079, 0.126)	50.13
66	274	Fighter, Slayer, Slayer, Tank, Tank	0.021	(-0.129, 0.171)	75.00
67	282	Mage, Mage, Mage, Marksman, Marksman	0.020	(-0.125, 0.178)	64.71
68	96	Controller, Fighter, Slayer, Slayer, Tank	0.020	(-0.121, 0.171)	56.76
69	139	Controller, Marksman, Marksman, Slayer, Specialist	0.020	(-0.116, 0.168)	53.64
70	135	Controller, Marksman, Marksman, Marksman, Slayer	0.020	(-0.124, 0.185)	70.59
71	243	Fighter, Mage, Slayer, Specialist, Tank	0.019	(-0.12, 0.162)	54.93
72	189	Fighter, Fighter, Mage, Slayer, Slayer	0.019	(-0.122, 0.176)	56.14
73	37	Controller, Controller, Marksman, Slayer, Slayer	0.019	(-0.13, 0.169)	55.10
74	262	Fighter, Marksman, Slayer, Specialist, Specialist	0.019	(-0.128, 0.169)	53.61
75	120	Controller, Mage, Marksman, Marksman, Tank	0.019	(-0.112, 0.157)	51.61
76	107	Controller, Mage, Mage, Marksman, Marksman	0.018	(-0.126, 0.169)	54.26
77	166	Fighter, Fighter, Fighter, Mage, Mage	0.017	(-0.122, 0.159)	60.00
78	319	Mage, Marksman, Marksman, Tank, Tank	0.017	(-0.135, 0.164)	52.69
79	187	Fighter, Fighter, Mage, Marksman, Specialist	0.016	(-0.088, 0.133)	50.43
80	295	Mage, Mage, Marksman, Slayer, Slayer	0.016	(-0.117, 0.144)	51.70
81	144	Controller, Marksman, Slayer, Slayer, Slayer	0.016	(-0.114, 0.152)	50.74
82	303	Mage, Mage, Slayer, Slayer, Tank	0.014	(-0.146, 0.152)	61.90
83	325	Mage, Marksman, Slayer, Tank, Tank	0.014	(-0.102, 0.143)	50.13
84	91	Controller, Fighter, Marksman, Specialist, Specialist	0.014	(-0.123, 0.157)	51.26
85	381	Slayer, Slayer, Tank, Tank, Tank	0.014	(-0.136, 0.169)	100.00
86	128	Controller, Mage, Slayer, Slayer, Specialist	0.014	(-0.132, 0.165)	58.33
87	286	Mage, Mage, Mage, Slayer, Slayer	0.014	(-0.132, 0.168)	83.33
88	153	Controller, Marksman, Tank, Tank, Tank	0.014	(-0.13, 0.158)	72.73
89	57	Controller, Fighter, Fighter, Mage, Specialist	0.013	(-0.124, 0.162)	53.03
90	334	Mage, Slayer, Slayer, Specialist, Tank	0.012	(-0.127, 0.168)	60.00

Table 13: Team Compositions Ranked by Strength, $\widehat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
91	377	Slayer, Slayer, Slayer, Tank, Tank	0.012	(-0.139, 0.174)	80.00
92	93	Controller, Fighter, Marksman, Tank, Tank	0.012	(-0.125, 0.149)	51.20
93	142	Controller, Marksman, Marksman, Specialist, Tank	0.012	(-0.131, 0.173)	54.24
94	50	Controller, Fighter, Fighter, Fighter, Marksman	0.012	(-0.089, 0.117)	49.55
95	346	Marksman, Marksman, Marksman, Specialist, Tank	0.012	(-0.132, 0.166)	66.67
96	111	Controller, Mage, Mage, Slayer, Slayer	0.012	(-0.132, 0.177)	58.33
97	159	Controller, Slayer, Slayer, Tank, Tank	0.011	(-0.127, 0.162)	100.00
98	64	Controller, Fighter, Fighter, Slayer, Specialist	0.011	(-0.123, 0.148)	54.35
99	112	Controller, Mage, Mage, Slayer, Specialist	0.011	(-0.137, 0.156)	61.11
100	17	Controller, Controller, Fighter, Marksman, Marksman	0.011	(-0.139, 0.153)	57.14
101	256	Fighter, Marksman, Marksman, Specialist, Specialist	0.011	(-0.134, 0.157)	58.62
102	74	Controller, Fighter, Mage, Marksman, Marksman	0.011	(-0.089, 0.12)	49.86
103	170	Fighter, Fighter, Fighter, Mage, Tank	0.010	(-0.13, 0.162)	51.79
104	137	Controller, Marksman, Marksman, Marksman, Tank	0.010	(-0.139, 0.167)	83.33
105	151	Controller, Marksman, Specialist, Specialist, Tank	0.010	(-0.134, 0.155)	55.56
106	357	Marksman, Marksman, Tank, Tank, Tank	0.010	(-0.143, 0.165)	60.00
107	158	Controller, Slayer, Slayer, Specialist, Tank	0.010	(-0.142, 0.162)	83.33
108	36	Controller, Controller, Marksman, Marksman, Tank	0.010	(-0.124, 0.167)	66.67
109	51	Controller, Fighter, Fighter, Fighter, Slayer	0.010	(-0.132, 0.16)	58.82
110	98	Controller, Fighter, Slayer, Specialist, Tank	0.009	(-0.135, 0.166)	55.00
111	369	Marksman, Specialist, Specialist, Specialist, Tank	0.009	(-0.14, 0.166)	80.00
112	217	Fighter, Mage, Mage, Mage, Specialist	0.008	(-0.136, 0.153)	66.67
113	13	Controller, Controller, Fighter, Mage, Marksman	0.008	(-0.113, 0.139)	50.00
114	201	Fighter, Fighter, Marksman, Slayer, Tank	0.008	(-0.076, 0.097)	48.99
115	227	Fighter, Mage, Mage, Specialist, Tank	0.008	(-0.136, 0.153)	53.85
116	251	Fighter, Marksman, Marksman, Marksman, Specialist	0.008	(-0.141, 0.17)	57.89
117	52	Controller, Fighter, Fighter, Fighter, Specialist	0.008	(-0.131, 0.154)	61.54
118	327	Mage, Marksman, Specialist, Specialist, Tank	0.008	(-0.131, 0.162)	51.39
119	114	Controller, Mage, Mage, Specialist, Specialist	0.008	(-0.144, 0.155)	100.00
120	34	Controller, Controller, Marksman, Marksman, Slayer	0.008	(-0.134, 0.163)	56.00
121	28	Controller, Controller, Mage, Marksman, Specialist	0.008	(-0.144, 0.16)	54.55
122	247	Fighter, Mage, Specialist, Tank, Tank	0.008	(-0.139, 0.149)	61.54
123	332	Mage, Slayer, Slayer, Slayer, Tank	0.007	(-0.146, 0.165)	56.25
124	41	Controller, Controller, Marksman, Specialist, Tank	0.007	(-0.143, 0.158)	66.67
125	280	Fighter, Tank, Tank, Tank, Tank	0.007	(-0.152, 0.172)	50.00
126	347	Marksman, Marksman, Marksman, Tank, Tank	0.007	(-0.151, 0.157)	75.00
127	143	Controller, Marksman, Marksman, Tank, Tank	0.007	(-0.152, 0.175)	52.00
128	94	Controller, Fighter, Slayer, Slayer, Slayer	0.007	(-0.139, 0.145)	60.00
129	191	Fighter, Fighter, Mage, Slayer, Tank	0.007	(-0.132, 0.142)	49.08
130	168	Fighter, Fighter, Fighter, Mage, Slayer	0.007	(-0.134, 0.141)	51.35
131	302	Mage, Mage, Slayer, Slayer, Specialist	0.007	(-0.147, 0.161)	57.14
132	239	Fighter, Mage, Slayer, Slayer, Slayer	0.007	(-0.15, 0.158)	53.85
133	20	Controller, Controller, Fighter, Marksman, Tank	0.007	(-0.135, 0.145)	51.11
134	174	Fighter, Fighter, Fighter, Marksman, Tank	0.007	(-0.113, 0.13)	49.33
135	117	Controller, Mage, Marksman, Marksman, Marksman	0.006	(-0.142, 0.155)	60.00

Table 14: Team Compositions Ranked by Strength, $\widehat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
136	182	Fighter, Fighter, Mage, Mage, Slayer	0.006	(-0.135, 0.15)	51.06
137	185	Fighter, Fighter, Mage, Marksman, Marksman	0.006	(-0.098, 0.121)	49.34
138	39	Controller, Controller, Marksman, Slayer, Tank	0.006	(-0.127, 0.15)	52.08
139	157	Controller, Slayer, Slayer, Specialist, Specialist	0.006	(-0.153, 0.159)	71.43
140	133	Controller, Mage, Specialist, Specialist, Specialist	0.006	(-0.145, 0.154)	100.00
141	278	Fighter, Slayer, Tank, Tank, Tank	0.006	(-0.143, 0.156)	66.67
142	61	Controller, Fighter, Fighter, Marksman, Specialist	0.006	(-0.108, 0.109)	49.22
143	293	Mage, Mage, Marksman, Marksman, Specialist	0.005	(-0.142, 0.147)	51.16
144	275	Fighter, Slayer, Specialist, Specialist, Specialist	0.005	(-0.143, 0.158)	100.00
145	245	Fighter, Mage, Specialist, Specialist, Specialist	0.005	(-0.145, 0.147)	100.00
146	352	Marksman, Marksman, Slayer, Specialist, Tank	0.005	(-0.136, 0.146)	50.44
147	308	Mage, Mage, Specialist, Specialist, Tank	0.005	(-0.147, 0.159)	100.00
148	35	Controller, Controller, Marksman, Marksman, Specialist	0.005	(-0.138, 0.145)	63.64
149	171	Fighter, Fighter, Fighter, Marksman, Marksman	0.005	(-0.142, 0.146)	48.57
150	276	Fighter, Slayer, Specialist, Specialist, Tank	0.005	(-0.142, 0.16)	57.14
151	82	Controller, Fighter, Mage, Specialist, Tank	0.005	(-0.139, 0.141)	51.85
152	226	Fighter, Mage, Mage, Specialist, Specialist	0.004	(-0.135, 0.158)	60.00
153	150	Controller, Marksman, Specialist, Specialist, Specialist	0.004	(-0.132, 0.162)	54.55
154	301	Mage, Mage, Slayer, Slayer, Slayer	0.004	(-0.144, 0.156)	80.00
155	290	Mage, Mage, Mage, Specialist, Tank	0.004	(-0.146, 0.152)	100.00
156	234	Fighter, Mage, Marksman, Slayer, Specialist	0.004	(-0.094, 0.105)	49.47
157	15	Controller, Controller, Fighter, Mage, Specialist	0.004	(-0.139, 0.148)	100.00
158	131	Controller, Mage, Slayer, Specialist, Tank	0.004	(-0.142, 0.156)	54.55
159	197	Fighter, Fighter, Marksman, Marksman, Specialist	0.004	(-0.14, 0.143)	50.00
160	329	Mage, Marksman, Tank, Tank, Tank	0.004	(-0.127, 0.141)	50.00
161	277	Fighter, Slayer, Specialist, Tank, Tank	0.004	(-0.147, 0.151)	71.43
162	33	Controller, Controller, Mage, Specialist, Tank	0.004	(-0.152, 0.138)	100.00
163	250	Fighter, Marksman, Marksman, Marksman, Slayer	0.004	(-0.147, 0.144)	50.00
164	216	Fighter, Mage, Mage, Mage, Slayer	0.003	(-0.148, 0.155)	54.17
165	248	Fighter, Mage, Tank, Tank, Tank	0.003	(-0.146, 0.156)	66.67
166	99	Controller, Fighter, Slayer, Tank, Tank	0.003	(-0.142, 0.149)	75.00
167	367	Marksman, Slayer, Tank, Tank, Tank	0.003	(-0.133, 0.147)	48.94
168	115	Controller, Mage, Mage, Specialist, Tank	0.003	(-0.151, 0.149)	66.67
169	265	Fighter, Marksman, Specialist, Specialist, Specialist	0.003	(-0.142, 0.145)	50.00
170	341	Marksman, Marksman, Marksman, Marksman, Slayer	0.003	(-0.141, 0.137)	100.00
171	354	Marksman, Marksman, Specialist, Specialist, Specialist	0.003	(-0.138, 0.154)	100.00
172	40	Controller, Controller, Marksman, Specialist, Specialist	0.003	(-0.146, 0.153)	66.67
173	379	Slayer, Slayer, Specialist, Specialist, Tank	0.002	(-0.137, 0.152)	50.00
174	342	Marksman, Marksman, Marksman, Slayer, Slayer	0.002	(-0.156, 0.159)	50.00
175	130	Controller, Mage, Slayer, Specialist, Specialist	0.002	(-0.142, 0.169)	60.00
176	102	Controller, Fighter, Specialist, Tank, Tank	0.002	(-0.143, 0.147)	66.67
177	161	Controller, Slayer, Specialist, Specialist, Tank	0.002	(-0.141, 0.163)	66.67
178	177	Fighter, Fighter, Fighter, Slayer, Tank	0.002	(-0.137, 0.151)	50.00
179	337	Mage, Slayer, Specialist, Specialist, Tank	0.002	(-0.148, 0.157)	45.45
180	105	Controller, Mage, Mage, Mage, Slayer	0.002	(-0.145, 0.165)	40.00

Table 15: Team Compositions Ranked by Strength, $\widehat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
181	42	Controller, Controller, Marksman, Tank, Tank	0.002	(-0.153, 0.159)	50.00
182	339	Mage, Slayer, Tank, Tank, Tank	0.002	(-0.149, 0.15)	50.00
183	242	Fighter, Mage, Slayer, Specialist, Specialist	0.001	(-0.148, 0.149)	54.55
184	31	Controller, Controller, Mage, Slayer, Specialist	0.001	(-0.14, 0.146)	50.00
185	331	Mage, Slayer, Slayer, Slayer, Specialist	0.001	(-0.153, 0.15)	60.00
186	378	Slayer, Slayer, Specialist, Specialist, Specialist	0.001	(-0.15, 0.151)	100.00
187	306	Mage, Mage, Slayer, Tank, Tank	0.001	(-0.147, 0.145)	50.00
188	364	Marksman, Slayer, Specialist, Specialist, Specialist	0.001	(-0.15, 0.14)	60.00
189	22	Controller, Controller, Fighter, Slayer, Specialist	0.000	(-0.155, 0.154)	50.00
190	155	Controller, Slayer, Slayer, Slayer, Specialist	0.000	(-0.143, 0.155)	50.00
191	175	Fighter, Fighter, Fighter, Slayer, Slayer	0.000	(-0.154, 0.139)	57.14
192	345	Marksman, Marksman, Marksman, Specialist, Specialist	0.000	(-0.15, 0.171)	50.00
193	318	Mage, Marksman, Marksman, Specialist, Tank	0.000	(-0.143, 0.134)	49.62
194	305	Mage, Mage, Slayer, Specialist, Tank	0.000	(-0.152, 0.153)	52.38
195	192	Fighter, Fighter, Mage, Specialist, Specialist	0.000	(-0.15, 0.143)	50.00
196	165	Fighter, Fighter, Fighter, Fighter, Tank	0.000	(-0.155, 0.154)	33.33
197	269	Fighter, Slayer, Slayer, Slayer, Slayer	0.000	(-0.156, 0.148)	0.00
198	160	Controller, Slayer, Specialist, Specialist, Specialist	0.000	(-0.154, 0.155)	0.00
199	249	Fighter, Marksman, Marksman, Marksman, Marksman	0.000	(-0.142, 0.148)	50.00
200	53	Controller, Fighter, Fighter, Fighter, Tank	0.000	(-0.146, 0.159)	50.00
201	140	Controller, Marksman, Marksman, Slayer, Tank	0.000	(-0.14, 0.15)	49.35
202	272	Fighter, Slayer, Slayer, Specialist, Specialist	0.000	(-0.139, 0.141)	57.14
203	164	Fighter, Fighter, Fighter, Fighter, Marksman	0.000	(-0.15, 0.151)	50.00
204	183	Fighter, Fighter, Mage, Mage, Specialist	0.000	(-0.14, 0.144)	50.00
205	320	Mage, Marksman, Slayer, Slayer, Slayer	0.000	(-0.147, 0.142)	48.94
206	343	Marksman, Marksman, Marksman, Slayer, Specialist	0.000	(-0.164, 0.146)	45.45
207	163	Fighter, Fighter, Fighter, Fighter, Mage	0.000	(-0.148, 0.14)	33.33
208	2	Controller, Controller, Controller, Fighter, Slayer	-0.001	(-0.144, 0.139)	100.00
209	100	Controller, Fighter, Specialist, Specialist, Specialist	-0.001	(-0.146, 0.15)	0.00
210	66	Controller, Fighter, Fighter, Specialist, Specialist	-0.001	(-0.153, 0.131)	50.00
211	375	Slayer, Slayer, Slayer, Specialist, Specialist	-0.001	(-0.16, 0.148)	50.00
212	210	Fighter, Fighter, Slayer, Tank, Tank	-0.001	(-0.141, 0.125)	45.45
213	12	Controller, Controller, Fighter, Mage, Mage	-0.001	(-0.155, 0.154)	33.33
214	373	Slayer, Slayer, Slayer, Slayer, Specialist	-0.001	(-0.155, 0.164)	50.00
215	95	Controller, Fighter, Slayer, Slayer, Specialist	-0.001	(-0.151, 0.138)	51.85
216	307	Mage, Mage, Specialist, Specialist, Specialist	-0.001	(-0.156, 0.156)	0.00
217	213	Fighter, Fighter, Specialist, Tank, Tank	-0.001	(-0.149, 0.148)	50.00
218	103	Controller, Mage, Mage, Mage, Mage	-0.001	(-0.139, 0.152)	50.00
219	338	Mage, Slayer, Specialist, Tank, Tank	-0.001	(-0.163, 0.144)	42.86
220	317	Mage, Marksman, Marksman, Specialist, Specialist	-0.001	(-0.146, 0.158)	47.37
221	68	Controller, Fighter, Fighter, Tank, Tank	-0.001	(-0.148, 0.155)	50.00
222	382	Slayer, Specialist, Specialist, Tank, Tank	-0.001	(-0.148, 0.148)	0.00
223	116	Controller, Mage, Mage, Tank, Tank	-0.001	(-0.156, 0.158)	0.00
224	30	Controller, Controller, Mage, Slayer, Slayer	-0.002	(-0.151, 0.151)	60.00
225	9	Controller, Controller, Fighter, Fighter, Slayer	-0.002	(-0.153, 0.149)	50.00

Table 16: Team Compositions Ranked by Strength, $\widehat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
226	287	Mage, Mage, Mage, Slayer, Specialist	-0.002	(-0.149, 0.141)	0.00
227	223	Fighter, Mage, Mage, Slayer, Slayer	-0.002	(-0.153, 0.14)	47.73
228	228	Fighter, Mage, Mage, Tank, Tank	-0.002	(-0.154, 0.154)	47.62
229	380	Slayer, Slayer, Specialist, Tank, Tank	-0.002	(-0.158, 0.145)	50.00
230	101	Controller, Fighter, Specialist, Specialist, Tank	-0.002	(-0.152, 0.142)	66.67
231	43	Controller, Controller, Slayer, Slayer, Slayer	-0.002	(-0.149, 0.136)	50.00
232	81	Controller, Fighter, Mage, Specialist, Specialist	-0.002	(-0.148, 0.15)	52.38
233	304	Mage, Mage, Slayer, Specialist, Specialist	-0.002	(-0.158, 0.139)	33.33
234	271	Fighter, Slayer, Slayer, Slayer, Tank	-0.003	(-0.146, 0.142)	50.00
235	47	Controller, Controller, Slayer, Tank, Tank	-0.003	(-0.15, 0.149)	0.00
236	340	Marksman, Marksman, Marksman, Marksman, Marksman	-0.003	(-0.16, 0.142)	0.00
237	363	Marksman, Slayer, Slayer, Tank, Tank	-0.003	(-0.123, 0.126)	49.33
238	206	Fighter, Fighter, Slayer, Slayer, Specialist	-0.003	(-0.152, 0.147)	50.00
239	134	Controller, Mage, Specialist, Specialist, Tank	-0.003	(-0.146, 0.141)	0.00
240	336	Mage, Slayer, Specialist, Specialist, Specialist	-0.003	(-0.15, 0.15)	33.33
241	162	Controller, Slayer, Specialist, Tank, Tank	-0.003	(-0.157, 0.157)	0.00
242	374	Slayer, Slayer, Slayer, Slayer, Tank	-0.003	(-0.145, 0.158)	50.00
243	289	Mage, Mage, Mage, Specialist, Specialist	-0.003	(-0.159, 0.148)	0.00
244	214	Fighter, Mage, Mage, Mage, Mage	-0.003	(-0.15, 0.146)	0.00
245	7	Controller, Controller, Fighter, Fighter, Mage	-0.003	(-0.149, 0.144)	45.45
246	3	Controller, Controller, Controller, Mage, Slayer	-0.004	(-0.147, 0.146)	0.00
247	233	Fighter, Mage, Marksman, Slayer, Slayer	-0.004	(-0.113, 0.095)	48.77
248	58	Controller, Fighter, Fighter, Mage, Tank	-0.004	(-0.148, 0.138)	48.84
249	176	Fighter, Fighter, Fighter, Slayer, Specialist	-0.004	(-0.149, 0.154)	42.86
250	23	Controller, Controller, Fighter, Slayer, Tank	-0.004	(-0.156, 0.148)	0.00
251	178	Fighter, Fighter, Fighter, Specialist, Specialist	-0.004	(-0.163, 0.144)	25.00
252	127	Controller, Mage, Slayer, Slayer, Slayer	-0.004	(-0.151, 0.162)	43.75
253	154	Controller, Slayer, Slayer, Slayer, Slayer	-0.004	(-0.147, 0.141)	0.00
254	21	Controller, Controller, Fighter, Slayer, Slayer	-0.004	(-0.142, 0.139)	45.45
255	368	Marksman, Specialist, Specialist, Specialist, Specialist	-0.004	(-0.153, 0.157)	0.00
256	10	Controller, Controller, Fighter, Fighter, Specialist	-0.004	(-0.161, 0.144)	0.00
257	1	Controller, Controller, Controller, Fighter, Marksman	-0.004	(-0.168, 0.142)	33.33
258	65	Controller, Fighter, Fighter, Slayer, Tank	-0.005	(-0.155, 0.141)	43.75
259	25	Controller, Controller, Mage, Mage, Slayer	-0.005	(-0.15, 0.133)	33.33
260	310	Mage, Marksman, Marksman, Marksman, Marksman	-0.005	(-0.164, 0.151)	50.00
261	279	Fighter, Specialist, Specialist, Tank, Tank	-0.005	(-0.151, 0.143)	25.00
262	45	Controller, Controller, Slayer, Slayer, Tank	-0.005	(-0.146, 0.133)	50.00
263	78	Controller, Fighter, Mage, Slayer, Slayer	-0.005	(-0.135, 0.134)	48.74
264	14	Controller, Controller, Fighter, Mage, Slayer	-0.005	(-0.15, 0.144)	42.86
265	309	Mage, Mage, Specialist, Tank, Tank	-0.005	(-0.16, 0.136)	40.00
266	370	Marksman, Specialist, Specialist, Tank, Tank	-0.005	(-0.149, 0.146)	45.45
267	46	Controller, Controller, Slayer, Specialist, Tank	-0.005	(-0.156, 0.139)	0.00
268	205	Fighter, Fighter, Slayer, Slayer, Slayer	-0.005	(-0.154, 0.139)	36.36
269	333	Mage, Slayer, Slayer, Specialist, Specialist	-0.005	(-0.161, 0.147)	33.33
270	44	Controller, Controller, Slayer, Slayer, Specialist	-0.005	(-0.166, 0.138)	0.00

Table 17: Team Compositions Ranked by Strength, $\widehat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
271	87	Controller, Fighter, Marksman, Marksman, Tank	-0.005	(-0.132, 0.126)	48.11
272	330	Mage, Slayer, Slayer, Slayer, Slayer	-0.005	(-0.157, 0.143)	33.33
273	67	Controller, Fighter, Fighter, Specialist, Tank	-0.005	(-0.159, 0.135)	45.45
274	211	Fighter, Fighter, Specialist, Specialist, Specialist	-0.005	(-0.162, 0.131)	0.00
275	11	Controller, Controller, Fighter, Fighter, Tank	-0.005	(-0.159, 0.151)	0.00
276	63	Controller, Fighter, Fighter, Slayer, Slayer	-0.006	(-0.146, 0.123)	46.67
277	29	Controller, Controller, Mage, Marksman, Tank	-0.006	(-0.153, 0.145)	46.43
278	156	Controller, Slayer, Slayer, Slayer, Tank	-0.006	(-0.159, 0.155)	25.00
279	83	Controller, Fighter, Mage, Tank, Tank	-0.006	(-0.159, 0.141)	41.67
280	4	Controller, Controller, Controller, Marksman, Slayer	-0.006	(-0.168, 0.152)	0.00
281	24	Controller, Controller, Mage, Mage, Marksman	-0.006	(-0.166, 0.137)	45.45
282	129	Controller, Mage, Slayer, Slayer, Tank	-0.007	(-0.146, 0.143)	47.37
283	84	Controller, Fighter, Marksman, Marksman, Marksman	-0.007	(-0.149, 0.141)	40.00
284	48	Controller, Fighter, Fighter, Fighter, Fighter	-0.007	(-0.144, 0.145)	0.00
285	106	Controller, Mage, Mage, Mage, Specialist	-0.007	(-0.15, 0.142)	0.00
286	16	Controller, Controller, Fighter, Mage, Tank	-0.007	(-0.162, 0.136)	0.00
287	270	Fighter, Slayer, Slayer, Slayer, Specialist	-0.007	(-0.146, 0.139)	20.00
288	132	Controller, Mage, Slayer, Tank, Tank	-0.007	(-0.166, 0.134)	42.86
289	152	Controller, Marksman, Specialist, Tank, Tank	-0.008	(-0.158, 0.13)	45.45
290	179	Fighter, Fighter, Fighter, Specialist, Tank	-0.008	(-0.176, 0.145)	40.00
291	312	Mage, Marksman, Marksman, Marksman, Specialist	-0.008	(-0.154, 0.145)	42.86
292	136	Controller, Marksman, Marksman, Marksman, Specialist	-0.008	(-0.168, 0.141)	25.00
293	209	Fighter, Fighter, Slayer, Specialist, Tank	-0.008	(-0.155, 0.141)	42.86
294	6	Controller, Controller, Controller, Marksman, Tank	-0.008	(-0.158, 0.137)	0.00
295	124	Controller, Mage, Marksman, Specialist, Specialist	-0.008	(-0.146, 0.134)	47.37
296	138	Controller, Marksman, Marksman, Slayer, Slayer	-0.008	(-0.15, 0.118)	47.12
297	349	Marksman, Marksman, Slayer, Slayer, Specialist	-0.008	(-0.156, 0.142)	46.34
298	355	Marksman, Marksman, Specialist, Specialist, Tank	-0.008	(-0.166, 0.156)	41.18
299	32	Controller, Controller, Mage, Slayer, Tank	-0.009	(-0.16, 0.146)	40.00
300	313	Mage, Marksman, Marksman, Marksman, Tank	-0.009	(-0.159, 0.141)	42.31
301	288	Mage, Mage, Mage, Slayer, Tank	-0.009	(-0.168, 0.138)	38.46
302	73	Controller, Fighter, Mage, Mage, Tank	-0.009	(-0.153, 0.128)	45.45
303	208	Fighter, Fighter, Slayer, Specialist, Specialist	-0.009	(-0.161, 0.141)	25.00
304	5	Controller, Controller, Controller, Marksman, Specialist	-0.009	(-0.161, 0.145)	0.00
305	97	Controller, Fighter, Slayer, Specialist, Specialist	-0.010	(-0.161, 0.124)	38.89
306	240	Fighter, Mage, Slayer, Slayer, Specialist	-0.010	(-0.152, 0.132)	45.00
307	359	Marksman, Slayer, Slayer, Slayer, Specialist	-0.010	(-0.155, 0.149)	46.30
308	252	Fighter, Marksman, Marksman, Marksman, Tank	-0.010	(-0.165, 0.134)	43.33
309	284	Mage, Mage, Mage, Marksman, Specialist	-0.010	(-0.163, 0.127)	41.67
310	218	Fighter, Mage, Mage, Mage, Tank	-0.010	(-0.164, 0.127)	40.00
311	172	Fighter, Fighter, Fighter, Marksman, Slayer	-0.010	(-0.147, 0.117)	48.50
312	207	Fighter, Fighter, Slayer, Slayer, Tank	-0.010	(-0.151, 0.143)	44.00
313	350	Marksman, Marksman, Slayer, Slayer, Tank	-0.010	(-0.144, 0.117)	47.29
314	372	Marksman, Tank, Tank, Tank, Tank	-0.011	(-0.175, 0.126)	0.00
315	212	Fighter, Fighter, Specialist, Specialist, Tank	-0.011	(-0.155, 0.146)	0.00

Table 18: Team Compositions Ranked by Strength, $\widehat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
316	113	Controller, Mage, Mage, Slayer, Tank	-0.011	(-0.153, 0.125)	38.46
317	371	Marksman, Specialist, Tank, Tank, Tank	-0.011	(-0.169, 0.134)	30.00
318	238	Fighter, Mage, Marksman, Tank, Tank	-0.011	(-0.105, 0.08)	48.42
319	351	Marksman, Marksman, Slayer, Specialist, Specialist	-0.011	(-0.16, 0.132)	30.77
320	311	Mage, Marksman, Marksman, Marksman, Slayer	-0.012	(-0.163, 0.142)	40.74
321	69	Controller, Fighter, Mage, Mage, Mage	-0.012	(-0.164, 0.13)	25.00
322	85	Controller, Fighter, Marksman, Marksman, Slayer	-0.012	(-0.114, 0.096)	48.27
323	173	Fighter, Fighter, Fighter, Marksman, Specialist	-0.012	(-0.161, 0.134)	45.83
324	119	Controller, Mage, Marksman, Marksman, Specialist	-0.012	(-0.14, 0.127)	46.67
325	326	Mage, Marksman, Specialist, Specialist, Specialist	-0.013	(-0.151, 0.133)	22.22
326	281	Mage, Mage, Mage, Mage, Marksman	-0.013	(-0.164, 0.134)	20.00
327	246	Fighter, Mage, Specialist, Specialist, Tank	-0.014	(-0.167, 0.135)	0.00
328	199	Fighter, Fighter, Marksman, Slayer, Slayer	-0.015	(-0.138, 0.104)	48.25
329	118	Controller, Mage, Marksman, Marksman, Slayer	-0.015	(-0.143, 0.114)	47.84
330	353	Marksman, Marksman, Slayer, Tank, Tank	-0.015	(-0.158, 0.121)	45.63
331	236	Fighter, Mage, Marksman, Specialist, Specialist	-0.016	(-0.164, 0.131)	47.41
332	360	Marksman, Slayer, Slayer, Slayer, Tank	-0.016	(-0.148, 0.112)	47.02
333	141	Controller, Marksman, Marksman, Specialist, Specialist	-0.017	(-0.165, 0.122)	20.00
334	268	Fighter, Marksman, Tank, Tank, Tank	-0.017	(-0.157, 0.116)	44.30
335	291	Mage, Mage, Marksman, Marksman, Marksman	-0.017	(-0.168, 0.12)	20.00
336	180	Fighter, Fighter, Mage, Mage, Mage	-0.017	(-0.169, 0.128)	37.04
337	273	Fighter, Slayer, Slayer, Specialist, Tank	-0.018	(-0.162, 0.123)	30.43
338	376	Slayer, Slayer, Slayer, Specialist, Tank	-0.018	(-0.182, 0.13)	10.00
339	224	Fighter, Mage, Mage, Slayer, Specialist	-0.018	(-0.159, 0.117)	42.42
340	195	Fighter, Fighter, Marksman, Marksman, Marksman	-0.018	(-0.159, 0.116)	40.00
341	204	Fighter, Fighter, Marksman, Tank, Tank	-0.019	(-0.137, 0.097)	46.99
342	348	Marksman, Marksman, Slayer, Slayer, Slayer	-0.019	(-0.166, 0.132)	38.71
343	298	Mage, Mage, Marksman, Specialist, Specialist	-0.020	(-0.162, 0.119)	31.25
344	315	Mage, Marksman, Marksman, Slayer, Specialist	-0.020	(-0.147, 0.1)	45.45
345	19	Controller, Controller, Fighter, Marksman, Specialist	-0.021	(-0.173, 0.125)	41.82
346	299	Mage, Mage, Marksman, Specialist, Tank	-0.022	(-0.175, 0.107)	45.28
347	237	Fighter, Mage, Marksman, Specialist, Tank	-0.022	(-0.115, 0.074)	47.97
348	184	Fighter, Fighter, Mage, Mage, Tank	-0.023	(-0.171, 0.12)	45.16
349	194	Fighter, Fighter, Mage, Tank, Tank	-0.023	(-0.164, 0.115)	37.14
350	104	Controller, Mage, Mage, Mage, Marksman	-0.024	(-0.174, 0.122)	36.36
351	202	Fighter, Fighter, Marksman, Specialist, Specialist	-0.025	(-0.182, 0.115)	41.18
352	316	Mage, Marksman, Marksman, Slayer, Tank	-0.025	(-0.154, 0.102)	47.12
353	328	Mage, Marksman, Specialist, Tank, Tank	-0.025	(-0.167, 0.107)	45.52
354	255	Fighter, Marksman, Marksman, Slayer, Tank	-0.025	(-0.149, 0.085)	47.49
355	362	Marksman, Slayer, Slayer, Specialist, Tank	-0.025	(-0.157, 0.096)	46.24
356	366	Marksman, Slayer, Specialist, Tank, Tank	-0.026	(-0.162, 0.101)	46.07
357	314	Mage, Marksman, Marksman, Slayer, Slayer	-0.027	(-0.17, 0.111)	44.55
358	26	Controller, Controller, Mage, Marksman, Marksman	-0.027	(-0.187, 0.115)	33.33
359	292	Mage, Mage, Marksman, Marksman, Slayer	-0.028	(-0.175, 0.107)	43.75
360	225	Fighter, Mage, Mage, Slayer, Tank	-0.028	(-0.167, 0.102)	43.59

Table 19: Team Compositions Ranked by Strength, $\hat{\lambda}_i$, from (3)

	Comp ID	Composition	Strength	95% CI	Win %
361	365	Marksman, Slayer, Specialist, Specialist, Tank	-0.028	(-0.172, 0.108)	42.11
362	186	Fighter, Fighter, Mage, Marksman, Slayer	-0.029	(-0.121, 0.055)	47.68
363	62	Controller, Fighter, Fighter, Marksman, Tank	-0.030	(-0.138, 0.072)	47.40
364	193	Fighter, Fighter, Mage, Specialist, Tank	-0.032	(-0.18, 0.096)	35.56
365	244	Fighter, Mage, Slayer, Tank, Tank	-0.032	(-0.173, 0.12)	40.74
366	344	Marksman, Marksman, Marksman, Slayer, Tank	-0.033	(-0.19, 0.094)	28.00
367	267	Fighter, Marksman, Specialist, Tank, Tank	-0.034	(-0.179, 0.093)	43.71
368	200	Fighter, Fighter, Marksman, Slayer, Specialist	-0.035	(-0.159, 0.094)	46.84
369	190	Fighter, Fighter, Mage, Slayer, Specialist	-0.037	(-0.197, 0.112)	36.54
370	221	Fighter, Mage, Mage, Marksman, Specialist	-0.037	(-0.163, 0.08)	46.18
371	126	Controller, Mage, Marksman, Tank, Tank	-0.039	(-0.18, 0.097)	43.87
372	86	Controller, Fighter, Marksman, Marksman, Specialist	-0.040	(-0.183, 0.087)	43.50
373	254	Fighter, Marksman, Marksman, Slayer, Specialist	-0.043	(-0.177, 0.088)	44.00
374	59	Controller, Fighter, Fighter, Marksman, Marksman	-0.048	(-0.173, 0.079)	44.53
375	261	Fighter, Marksman, Slayer, Slayer, Tank	-0.048	(-0.146, 0.046)	46.79
376	167	Fighter, Fighter, Fighter, Mage, Marksman	-0.048	(-0.167, 0.066)	45.63
377	230	Fighter, Mage, Marksman, Marksman, Slayer	-0.048	(-0.156, 0.058)	46.23
378	229	Fighter, Mage, Marksman, Marksman, Marksman	-0.048	(-0.213, 0.089)	35.21
379	253	Fighter, Marksman, Marksman, Slayer, Slayer	-0.053	(-0.191, 0.07)	43.85
380	196	Fighter, Fighter, Marksman, Marksman, Slayer	-0.064	(-0.187, 0.046)	43.85
381	220	Fighter, Mage, Mage, Marksman, Slayer	-0.065	(-0.181, 0.028)	45.68
382	215	Fighter, Mage, Mage, Mage, Marksman	-0.104	(-0.278, 0.033)	34.57

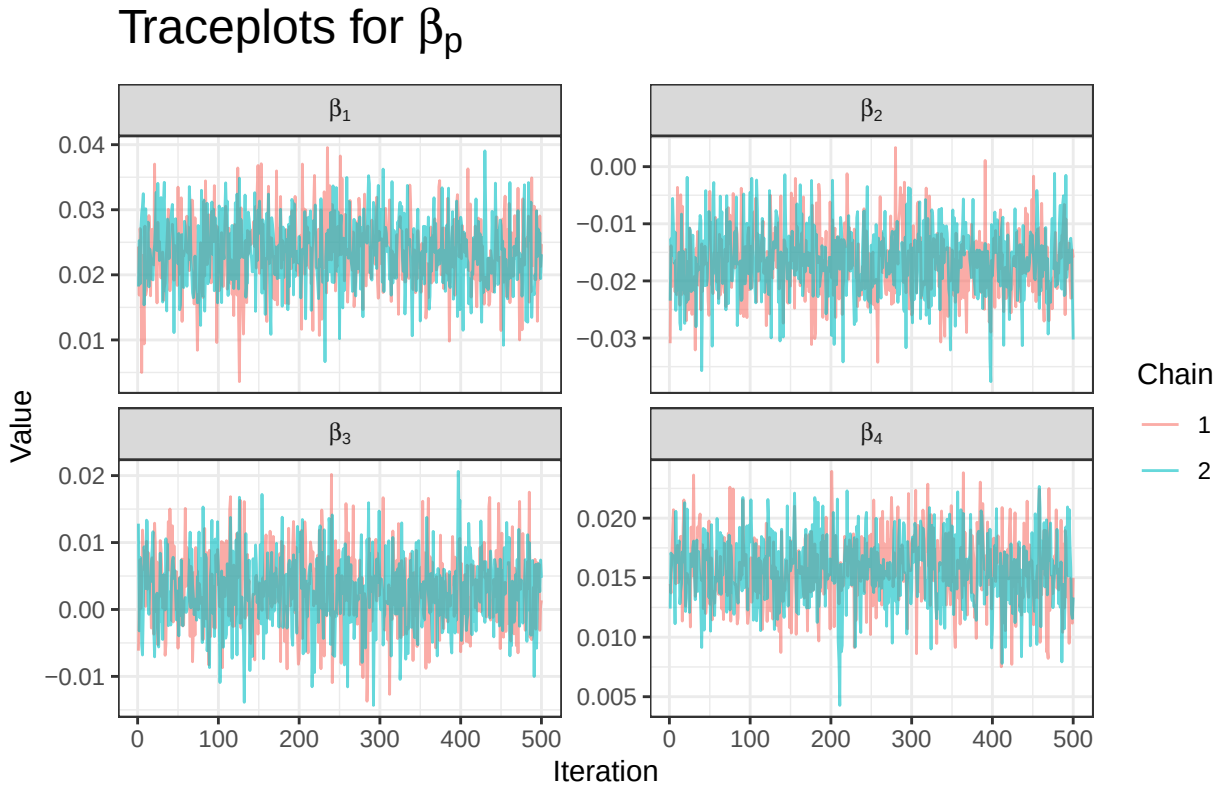

Figure 5

Table 20: $\hat{R}$ values for λ_i, β_p, σ^2_{comp} from (3)

Min	2.5%	25%	50%	75%	97.5%	Max
0.998	0.998	0.999	1	1.001	1.006	1.027

8.6 Sensitivity Analysis