RALLY SCORING VS SIDEOUT SCORING

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1. INTRODUCTION

In this document I report on experiments and analysis done to determine the effects of Rally scoring versus sideout scoring. This work is motivated by the game of volleyball, though the results are described in a general enough way as to be applicable to a certain class of random processes. This work is empirical in nature, and I present no analytic results, but only the description and results of a set of experiments designed to examine the following:

- Is a team more likely to win via sideout scoring or rally scoring?
- Can we make it such that the same team be as likely to win in both rally and sideout scoring?
- What is the average game length for both types of scoring?

This paper shows, through experimental analysis of a model for volleyball, that a switch to rally scoring should set the max score to be between 25 and 35. Further, we show rally scoring to take more servers to decide a game on average, while allowing a much smaller standard deviation and much shorter "long" games.

2. EXPERIMENTAL SETUP

Volleyball is a team sport played in rounds. There are two sides, each with the ability to win each round. Every round (rally, in volleyball lingo) has a winner. The specific details of a round are inconsequential to this analysis. Each round, one of the two teams is "on serve". Also, there is no tie: each round allows either a winner or a looser. If a team wins a round, then they are "on serve" in the next round.

The point of the game is to score points by winning rounds. The two scoring systems are rally scoring and sideout scoring. In both cases, teams are playing to amass a certain number of points, which we will call n. The first team to have more than n points and at least 2 points more than the opponent is the winner [1]. For instance, if n is 15 (we are playing to 15 points), the game is over when the score is 15-13: the first team has at least 15 points and at least two more points than the opponent. If the score is 20-21, however, the game is not over, despite the face that both scores are above the maximum of 15, because they are only one point apart.

The rally and sideout scoring systems differ in how they assign points. Rally scoring is simpler: in rally scoring, a team scores a point for every round won. On the other hand, sideout scoring awards a point only if a team is "on serve" when they win a round. So in rally scoring, team a team can score a point no matter who is "on serve", while in sideout scoring only the "on serve" team may score a point.

Recently volleyball has moved from a sideout scoring system where the game is won at 15 points to a rally scoring system where the game is won at 25 points. We call these

[1] This is the standard "win by two" rule.

systems sideout-15 and rally-25. The reasoning being that rally scoring "will shorten long matches and add excitement, it maintains the basic structure of the game, provides chances for catch-up" [2]. Our experiments verify these results, with the exception that rally-30 or rally-35 might more closely give the same results as sideout-15.

For our experiments, we consider the two teams p_1 and p_2 and their chances of winning a round of play. Let win_1 be the probability that player p_1 wins any given round, and let win_2 be the probability that player p_2 wins any given round. Notice that $win_1 = 1 - win_2$. Given the winning percentage for player p_1, and n, the number of points required for a win, it is easy to use a random process to compute a winner. By running that random process an appropriate number of times (in this case, 2500) we can estimate the likely-hood that p_1 will win a game to n given p_1's probability of winning a given round. So, for instance, given that p_1 wins 60% of the rounds it plays, we can determine p_1's probability of winning a game to 15 under both rally scoring and sideout scoring.

3. Results part I

Here we report the results of the experiments. In particular, a team winning 60% of the rounds will win a game to 15 88% of the time under rally scoring and 95% of the time under sideout scoring, with the average game taking 26 servers for rally scoring and 40 serves for sideout scoring. As a point of interest, the team winning 60% of the rounds wins a rally game to 25 92% of the time with an average of 43 serves.

From figures 1 and 2 we see that for rally scoring, a player's probability of winning the game is, for the same n, more closely correlated to the player's probability of winning a round than it is for sideout scoring. This is contrary to sideout scoring, where the player with the higher round win probability is more likely to win the game. To see this more clearly, look at 3, which shows the sideout curves to be much steeper than the rally ones.

General sideout volleyball games have $n = 15$, that is, they play till one team has 15 points. As such, we'd like to determine the value for n which, under rally scoring rules, changes the game the least. For our purposes, this means that the round win vs game win curve should be the same for the new kind of rally scoring. As such, we considered the average distance between the rally scoring curves and the sideout-15 curve. We got the following results:

Rally Points	Distance from sideout-15
5	133.57
10	71.13
15	40.03
20	21.42
25	13.62
30	13.64
35	18.71
40	26.15
45	30.40
50	35.18

These tell us that either rally-25 or rally-30 would give us curves similar to sideout-15. Looking at figure 4, we see the curves to be very similar.

So, now that we've established that sideout-15 and rally-25 allow the same win results (according to our simple model), we can examine the game lengths.

[2] FIVB: http://www.volleyball.org/rules/rallyscoring.html

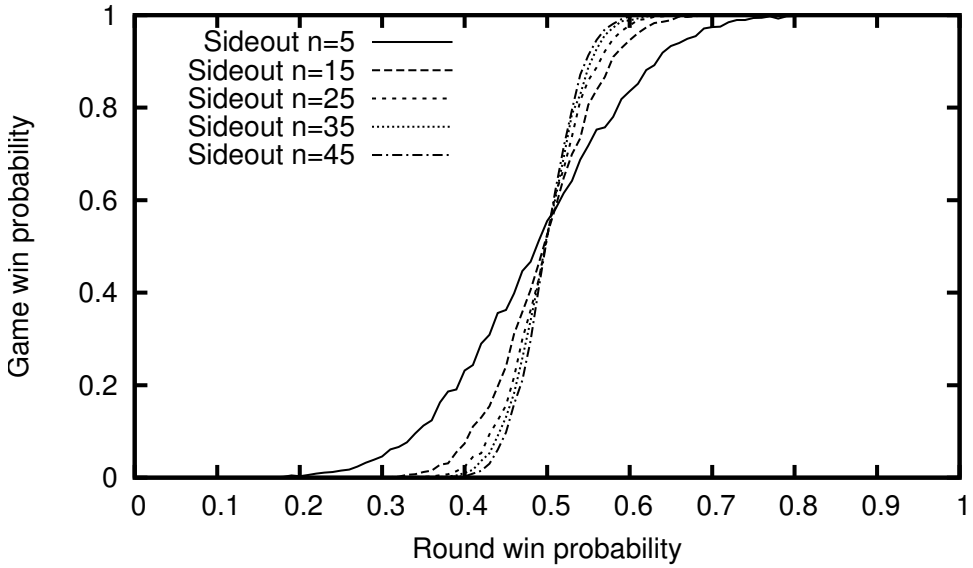

FIGURE 1. This shows the relation of p_1's round win and game win probabilities under sideout scoring. p_1 always starts "on serve". n is the number of points a player must amass to win the game.

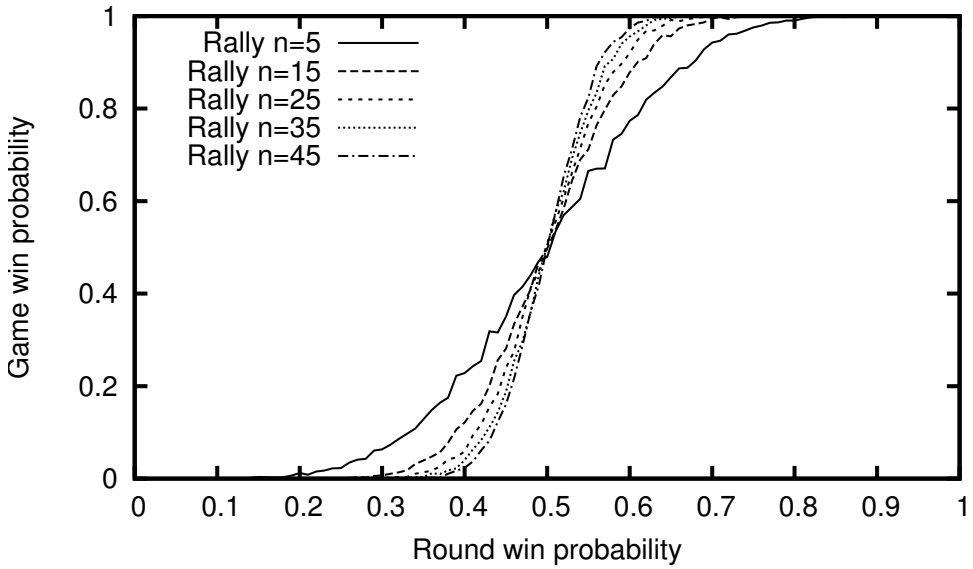

FIGURE 2. This shows the relation of p_1's round win and game win probabilities. p_1 always starts "on serve". n is the number of points a player must amass to win the game.

In figure 5 we see the average and maximum game length for sideout-15 and rally-25. This figure shows rally-25 games taking more points to decide generally (excepting games where the win probability is near 50%). However, rally-25 games have a lower standard

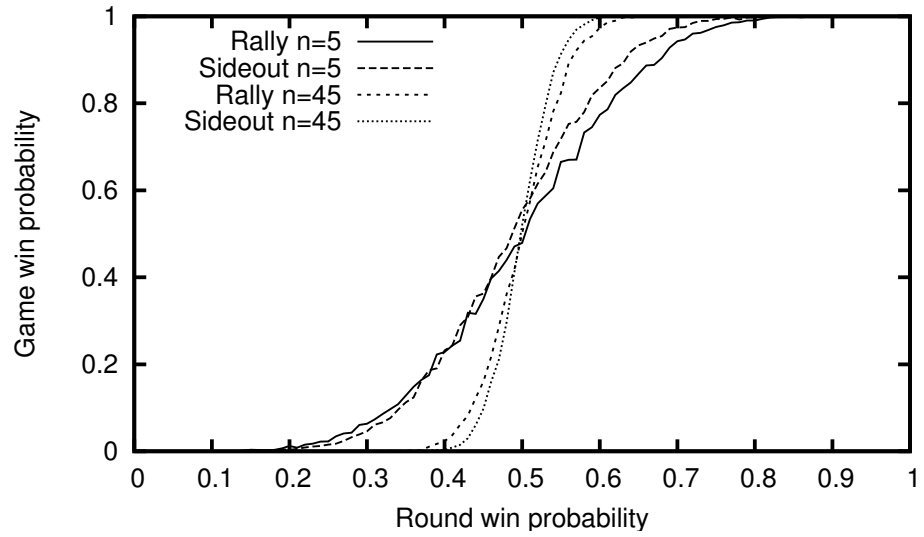

FIGURE 3. This shows the relation of p_1's round win and game win probabilities. p_1 always starts "on serve". n is the number of points a player must amass to win the game.

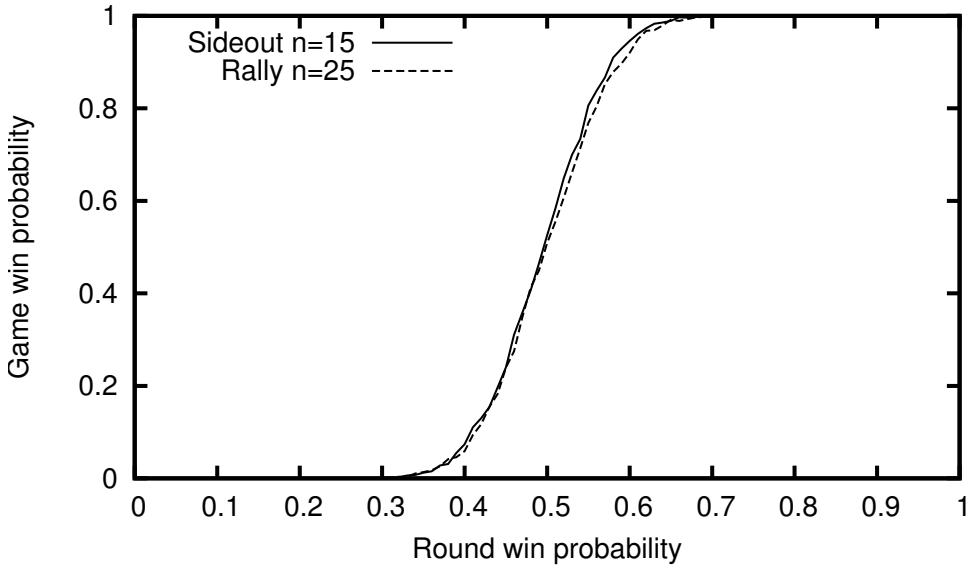

FIGURE 4. This shows the relation of p_1's round win and game win probabilities. p_1 always starts "on serve". n is the number of points a player must amass to win the game.

devaition as can be seen in figure 6. This means that while sideout-15 games are likely to take fewer rounds than rally-25 games, rally-25 games are much less likely to take many more rounds than expected.

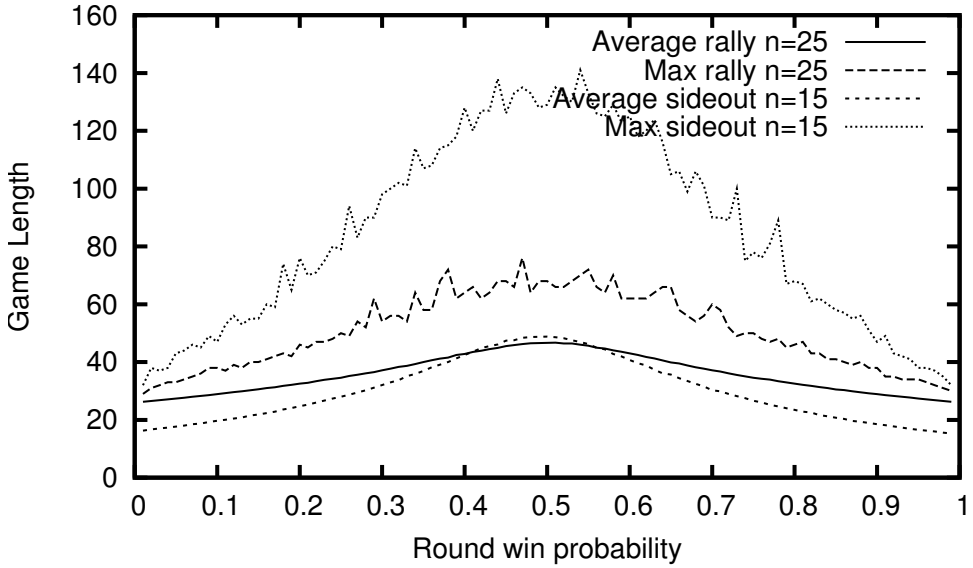

FIGURE 5. This show the round win probability's relation to the game's average and max length. The max length is the maximum game length seen in 2500 runs.

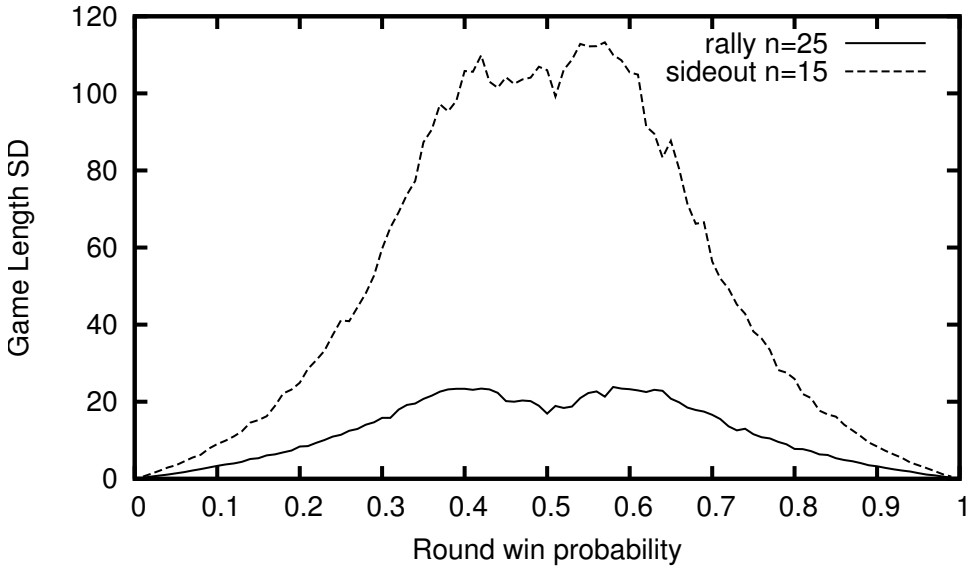

FIGURE 6. This show the round win probability's relation to the game length's standard deviation.

4. POTENTIAL ISSUE AND A NEW MODEL

All of these results come from a model of volleyball which assumes team p_1 will win with probability win_1 regardless of who is serving. Volleyball is a very offensive game, and there is a certain advantage to the receiving team. I was unable to find good statistics

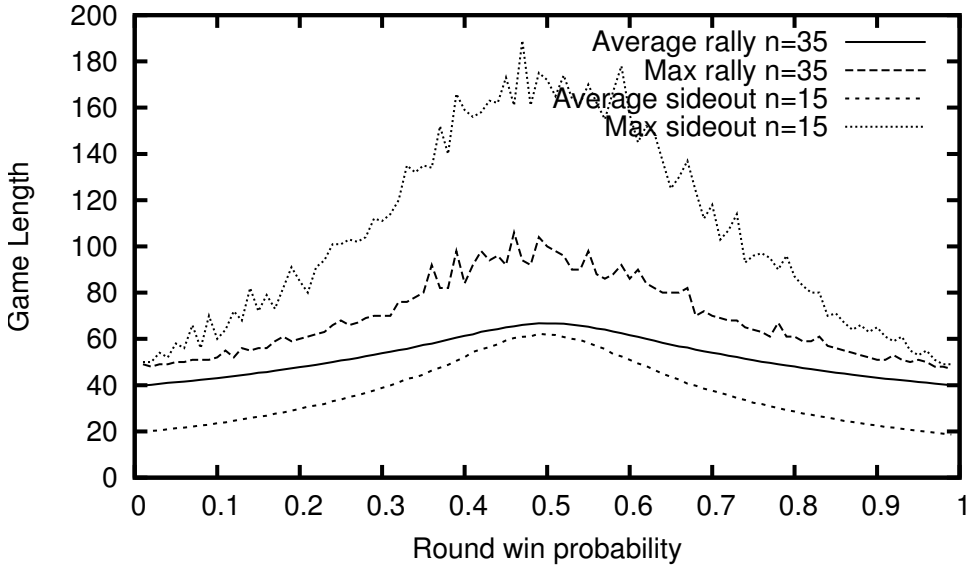

FIGURE 7. This show the round win probability's relation to the number of rounds (servers) in the game. For these games, the receiving team received a bonus of plus 10%.

on this, but my intuition is that a team is more likely to score should it be receiving. As such, it may be prudent to change the model.

The new model gives a bonus of b to the receiving team. So, if team p_1 is on server, the probability p_1 will win the point is $win_1 - b$, and if p_1 is receiving, the probability p_1 will win is $win_1 + b$. Apart from that change, the model is exactly as described above.

5. RESULTS II

We run the same experiments, and the graphs look similar to those above with the following notable differences.

If we again compute the differences between sideout-15 and rally scoring, we get this table:

Rally Points	Distance from sideout-15
5	135.757575757576
10	80.3939393939394
15	50.8686868686869
20	32.6262626262626
25	19.8484848484849
30	12.1111111111111
35	8.32323232323232
40	12.3131313131313
45	15.9090909090909
50	20.6262626262626

This suggests rally-35 might be more similar to sideout-15 than rally-25. If we look at average game length (in graph 7), we see that the rally-35 games are longer on average than sideout-15, though the longest games are still much shorter.

6. Conclusion

We here conclude that the transition from sideout to rally scoring in volleyball should not affect the game's structure too drastically. Our conclusion is based on assumptions that gloss over teams' specific abilities and weaknesses, using only a round-win percentage to characterize a team. Under such assumptions, however, and allowing for the possibility of there being implicit disadvantage to being the serving team, rally scoring can be made to allow a specific team to be as likely to win under rally scoring as they were likely to win under sideout scoring.

There is issue, however, with the number of points that should be required for sideout scoring. Under the assumption that the receiving team has no advantage, rally scoring to 25 gives winning percentages which are very similar to sideout scoring to 15. If we assume, however, that the receiving team is just 10% more likely to win a point, then the correct sort of rally scoring should be to 35.

With respect to the game's length, we see rally-25 and rally-35 to be longer on average than sideout-15 (in most cases). The win for rally scoring, however, comes when we consider that the longest rally games are substantially shorter than the longest sideout games. Further, it is much easier to predict the number of serves required to finish a rally game than in a sideout game. These are advantages for a sport wishing to be more spectator-friendly.