The Effect of Introducing Bonus Elo Rating for Win or Lose Streaks

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Abstract—One of the criticisms of the Elo rating system is that a player with a big difference between his skill and rating does not grow to their skill very fast. The primary objective of this paper is to identify the effects of introducing a bonus rating for a win or lose streaks for a player concerning this problem. We made a simulation where every player had a rating of 1500 and had to go to their skill as soon as possible. The other simulation we made, is where new players are introduced in a balanced environment where their skill and Elo rating differed by 400 points.

The results of this research suggest that the streak mechanism decreases the difference between the Elo rating and skill faster than without the streak mechanism. The results of the streak mechanism were varied more since it introduced new uncertainty in the results, namely the change to receive more rating. The result that the difference between rating and skill is decreasing faster, is an improvement to the current Elo rating system. It also might provide more motivation to the player to gain and hold a win streak. Further investigation could be to see whether there is a way to let the absolute amount of Elo rating stay the same. Another possible future study is to see what this mechanism does in a continuous environment where players enter and leave.

Index Terms—Streak, Streak mechanism, Improving Elo rating system

I. INTRODUCTION

The Elo rating of a player should represent his skill in the game. Too big of a gap between the skill of a player and his current Elo rating means that the player has a high likeness of playing against opponents that are either too weak or too strong, resulting in a less enjoyable experience. [1] Closing this gap can take many rounds [3] but it should take as little games as possible. This paper introduces a new streak mechanism for Elo ranking and compares it to the regular Elo ranking via comparable simulations. This streak mechanism increases the Elo score of a player more than the Elo rating system does, by multiplying it by a certain factor called the 'Streak Multiplier' after winning or losing a set amount of times consecutively. The results will be analyzed to see whether the streak mechanism is a good solution for the problem.

II. METHODS

To gather data for this paper, multiple simulations with different configurations are used. These configurations all have a different purpose on reflecting the effects of the bonus Elo rating versus the case where the bonus Elo rating is not accounted for.

A. Static Simulation Information

Each simulation consists of a pool of 100 players which all play 100 matches. The list of players is sorted on the current Elo rating of a player after each round, which will then be used for matchmaking. The matches are then formed by groups of two based on this list, such that player one plays against player two and player three plays against player four, and so on. The base K for each match is set to 16. The skill of a player is defined by an internal Elo score that reflects how good the player actually is. This Elo score is used when calculating the results of a match. This Elo score also stays static during the two hundred matches played. The skill of these players is distributed with a Poisson-function with a lambda of four. As Elo mentioned: 'The assumption of a normal distribution of chess performance is questionable. Chess ratings are not normally distributed — they are positively skewed' [2, p. 155]. Consequently, the Poisson-function is used to approach this distribution. The skill of a player is used for deciding which player wins a match.

B. Streak Mechanism

All players have a counter that represents a number of consecutive wins or losses. The player will receive a bonus Elo rating once a player is above the streak activation threshold. We have set this threshold to three. The bonus rating is calculated with the multiplied base K by the streak multiplier. The streak multiplier in our simulation is set to two. Calculating the new Elo score with a streak multiplier is done with: newElo(P) = oldElo(P) + streakMultiplier * baseK * (score(P) - expected(P)), where expected(P) is the expected score of player P in this match, and score(P) is 0 if P loses, 0.5 if P plays a draw, and 1 if P wins.

The bonus Elo rating is only of influence for the player that wins or loses a match and has a streak respectively. The other player of that match does not get an advantage or disadvantage for winning or losing the match against the player that has a streak. The positive streak will reset when losing or playing a draw. The negative streak will reset when winning or playing a draw.

C. Configurations

There are four configurations which all share the 'Static Simulation Information' (II-A), but have some additional properties that address certain fields of effect on the streak mechanism.
1) Same start Elo without the streak mechanism: Every player starts with an Elo rating of 1500. The new Elo ratings are calculated normally.

2) Same start Elo with the streak mechanism: This configuration is the same as 'Same start Elo without the streak mechanism' (II-C.1), but it implements the streak mechanism to calculate new Elo ratings.

3) Introducing new players without the streak mechanism: This configuration counts 90 initial players that have the same Elo rating as skill. It also counts ten new players with an Elo rating of 1500, of which five have a skill of 1900, and five have a skill of 1100. This configuration calculates the new Elo ratings normally.

4) Introducing new players with the streak mechanism: This configuration is the same as 'Introducing new players without the streak mechanism' (II-C.3), but it implements the streak mechanism to calculate new Elo ratings.

III. RESULTS

Each configuration of a simulation was run with the same players 25 times and then repeated four times with newly instantiated players to a total of 100 runs per configuration. The output of a simulation is the average absolute difference between rating and skill of all players in the simulation for a given round.

This resulted in being able to compute the average of these average differences per round over the 100 runs. The results also include the corresponding population standard deviation functioning as error bars compared to the average of all these runs.

Additional diagrams and the raw data behind the results can be found in the Supplementary Online Materials (SOM) which is linked from the Appendix [V].

A. Results regarding the 'same start Elo rating' configurations

The averaged results for the simulations II-C.3 and II-C.4 can also be combined into one graph expressing the correlation between these two simulations. This principle is shown in figure 2.

IV. DISCUSSION

A. Observations regarding the 'same start Elo rating' configurations

The simulation with the streak mechanism, shown in figure 1, has a lower average gap between the Elo rating and skill during all 100 rounds played. This contains an average difference of 78 compared to 91 for the simulation without streak mechanism. The smaller gap means an improvement compared to the standard Elo rating mechanism, at least for the first 100 rounds played with a streak mechanism. The slope of the streak simulation is steeper in the first 20 rounds compared to the normal simulation, namely -1.4 to -0.9 respectively. The slope of the streak simulation is getting closer to zero the more rounds played, having an average slope of only -0.07 in the last twenty rounds. In contrast, the line of the normal simulation stays at an average slope of -0.2 in the same rounds. The difference gap of the two configurations is 12 at the end of the simulation. This means that the performance of the streak simulation is only slightly better than the normal simulation in the longer run. The error bars on the streak simulation are much bigger with an average of 2.3 compared to the 1.4 of the normal simulation. This means that the normal simulation is almost twice as stable as the streak simulation.
B. Observations regarding the ‘introducing new players’ configurations

Figure 2 shows that the simulation with the streak mechanism has a lower average gap for all 100 rounds compared to the normal simulation: The streak simulation having an average gap of 64 and the normal simulation having an average gap of 131. This means that the new players are on average twice as close to their skill level with the streak mechanism. The slope of the streak is decreasing more over time than the normal simulation, which means that the lines will eventually meet. The streak mechanism is only beneficial up until that point. The error bars of the streak simulation are only slightly higher than the normal simulation: 10.0 and 8.5 respectively, meaning that the streak simulation is equally stable as the normal simulation and that it is consistently better.

C. Overall results

Having a streak mechanism decreases the gap between the Elo score and skill in the first 100 matches played in both simulation configurations. The streak mechanism has a decreasing performance compared to the almost linear performance of the normal Elo rating system. These results are somewhat comparable with the results of research performed by Sullivan and Cronin. [4] Although their setup was different, they also concluded that a streak mechanism has a positive effect.

V. Conclusion

The problem addressed in this paper is that when the skill of a player differs substantially from its Elo rating, the player slowly moves towards his actual skill. It is furthermore less enjoyable for a player to play against opponents that differ in skill compared to their own. This research was intended to fasten the process of moving the player’s Elo rating towards its skill and to observe the general effects on this process.

The streak mechanism we introduced decreased the gap between Elo rating and actual skill for the entire duration of both simulations. It does add more variation to the Elo rating once all players are somewhat near their skill than they would have without the streak bonus. The difference in gaps between the normal and the streak simulation get smaller the more rounds played.

The discovery of these effects is a possible improvement to the current existing Elo rating system as it allows players to approach their skill level much quicker. There might even be another advantage since players might be extra motivated on gaining and holding streak. This research opens another way to look at this problem, and further research could be deducted from this one.

The research that is left to be done is to see whether this process could be improved to force the absolute Elo rating of all players summed up to stay the same while applying bonus rating when holding a streak. Another possible future research is to see what form of applying bonus rating according to a match is best for the Elo rating environment. An additional research topic is to deploy this mechanism in a continuous environment where players enter and leave.

APPENDIX

Supplementary Online Materials can be found on https://github.com/Badbond/Paper-OMG-SOM. This holds the raw fetched data and corresponding diagrams.

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REFERENCES
