A simulation approach: Why are Korean teams so hard to defeat

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A brief game introduction

I started palying League of Legends since season 3 (year 2013), which is also the year I started following professional LOL games. Since then, Korean teams have been dominating every single international tournament, especially in Worlds – the most important tournament every season. Korean teams have never missed a single world championship since the establisment of LCK (also known as OGN before season 4), the Korean LOL professional league. For five year straight, the rest of the world have been united to attempt to defeat Korean teams, yet only EDG was able to beat SKT in the Grand Finale of 2015 Mid Season Invitation.

With the evolution of the game itself and the game strategies, the gap between Korean and non-Korean teams are shrinking. Professional players all over the world are getting extremely close regarding game understanding and mechanics, yet teams in different regions are forming their own play styles in a way that some regions specifically counters others. Just about half a year ago, RNG almost turned down SKT in the semi-final match of Season 7 Worlds. Though the Chinese team lost in this best of 5 (BO5) match, they demonstrated great synergy and mechanics throughout all five games. The series was rather a close match than a "Korean-team-once-again-dominating-the-match" story.

Commonsensically, people in the Leagues community are all aware of that it is fairly hard to defeat a Korean team in a BO5 series. But what about just one single match? In S4 - S7 Worlds, only 3 out of 12 teams finished group stage (in the format of Round-robin Single-elimination), which means Korean teams are totally defeatable in BO1. It is well-known that Korean teams are more professional in self-adjustment, game strategy variety and maintaining a constant competitive level throughout a BO5 series, which (thanks to the coach team and developement of Korean E-sports industry) undeniably gave them advantage on an international stage. But let's roll things back a little bit. In this post, I am not going to analyze any strategic side of the games. Rather, I will use a pure statistical approach to explain why it is much easier to disappoint a Korean team in BO1 than in BO5?

A probabilistic approach

In data science, Monte Carlo Simulation is one of the most powerful tools for its flexibility. In general, if a problem can be started probabilistically, we will rely on random sampling based on pre-defined probability and rules to obtain numerical results to simulate what might happen in the real life. Back to our League of Legends BO5 match case, a probability of winning one single game is assgined to the two sides of the match, namely Korean team and non-Korean team. Conventionally, Korean team will get a winning probability greater than 0.5 since they were almost always favored in any match up on international stages. Then, we are going to use this probability, which follows a binomial distribution, to simulate the result of a whole BO5 match. If we simulate hundreds and thousands of games, we can aggregate the results of all of the simulations and find out the overall winning probability of the Korean teams.

```
#Simulation Approach

##### Define the funciont to simulate a series of game
game_sim <- function (num_of_games, team_win_rate, best_of){
    #for example, you have to win 3 games to win a bo5
```

```
    win_point <- (best_of + 1) / 2
    probability <- rep(0, num_of_games)
    index <- seq(1,5000)
    for (i in 1:num_of_games){

        num_victory <- 0

        for (j in 1:i){

            result <- sum(rbinom(best_of, 1, team_win_rate))
            # if the team wins more than 3 games, then we record it as a
            # victory of the bo5 series
            if (result >= win_point){
                num_victory = num_victory + 1
            }

             probability[i] <- num_victory / i
        }
    }
    df <- data.frame(index,  probability)
    return(df)
}
```

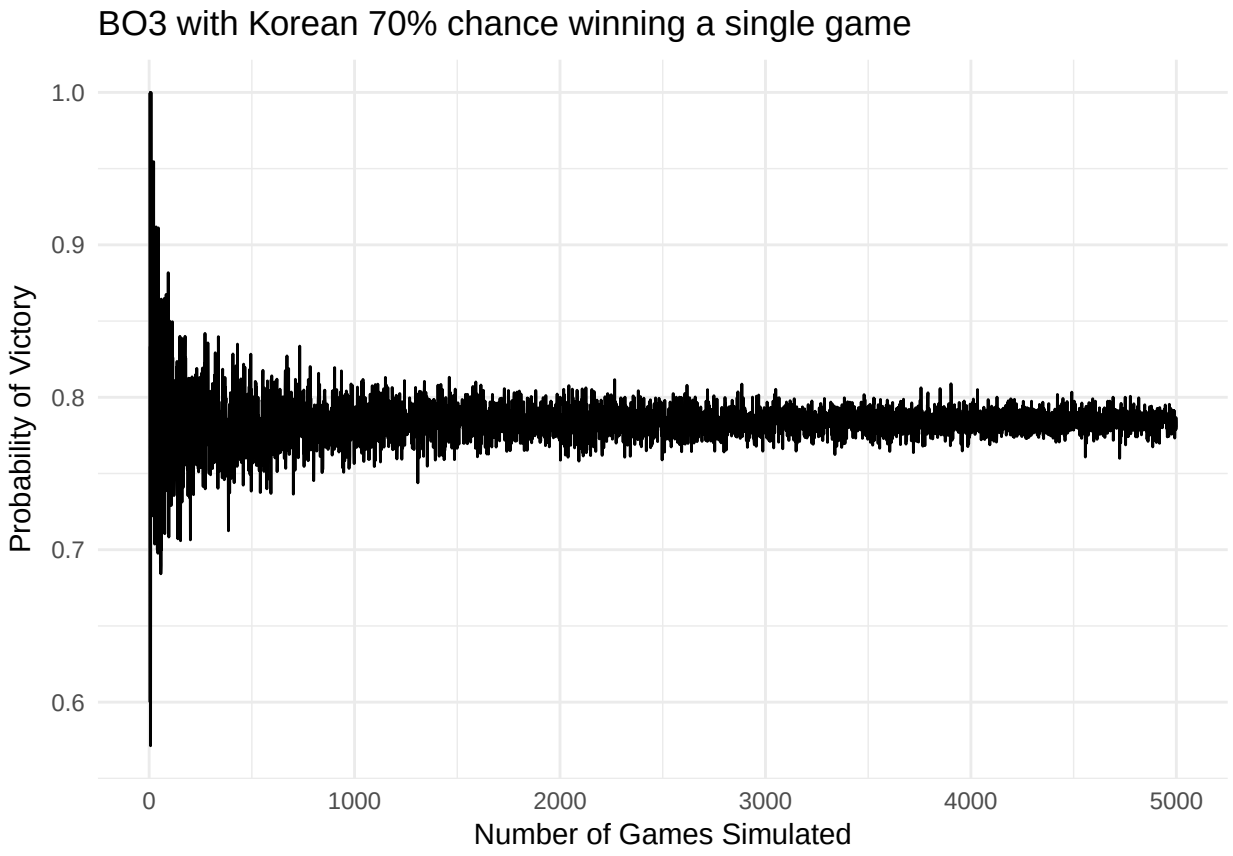
First simulation: What is the winning probability?

For a tournament, games are usually played in the form of BO3 or BO5. As today's topic is to understand why Korean teams are beatable in BO1 but not as much in BO5, I used the same probability to simulate the result for both BO3 and BO5 to investigate the relationship between the overall winning probability and number of games played.

Though in real life, this probability of winning one single game will be influenced by many other factors such as patches, champions ban-pick and home-away standings. For the sake of calculation simplicity, we assgin a fixed probability to each of the team (In fact, in the long-run, the winning probability will theoritically still converge to one specific number regardless other effects). If we assume Korean teams are still dominating the games, so in the first simulation, I assign the probability of them winning one single game is as high as 70%. After simulating 5000 thousand BO3, the plot converges to 0.8 eventually, meaning that Korean team won 80% of those BO3 matches. Yet for BO5, surprisingly (or maybe not?) this result converges to around 85%.

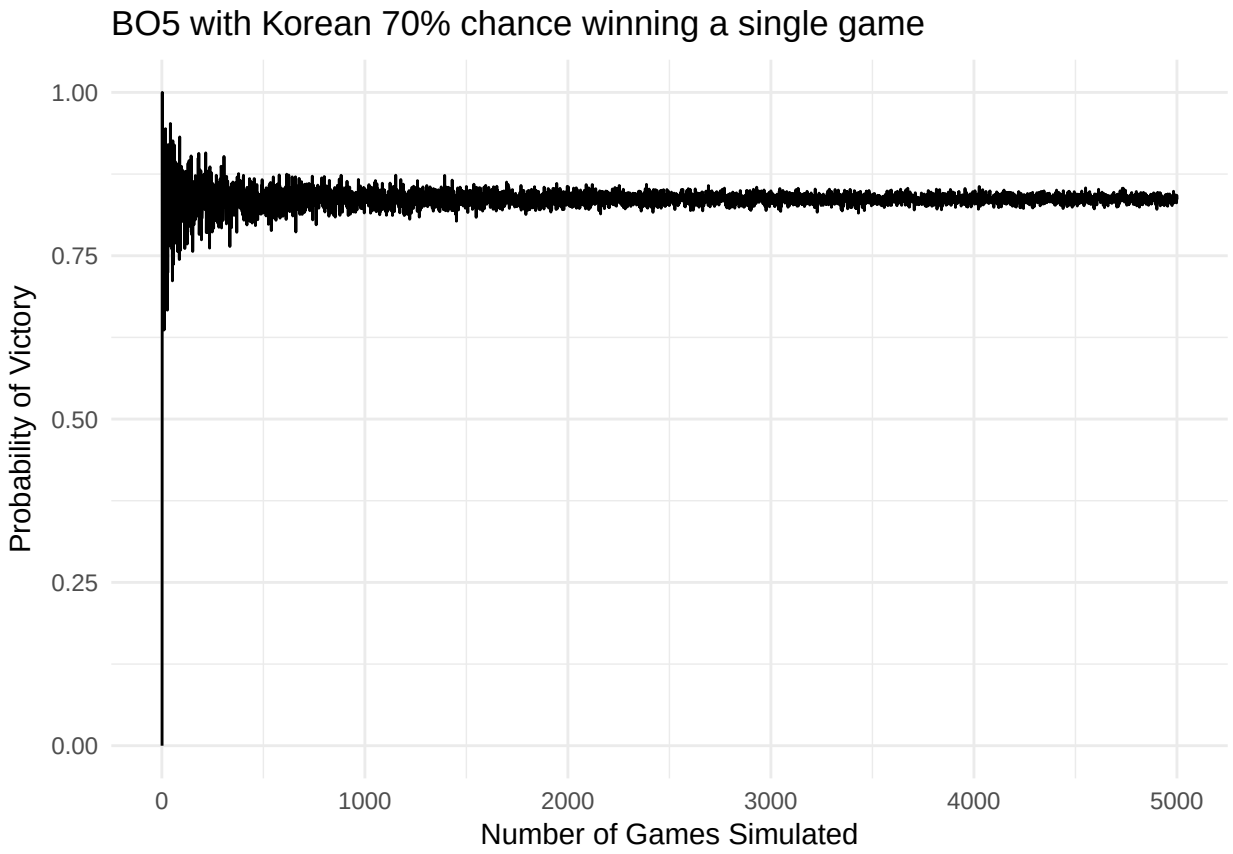
```
# A simulation of a bo3 with winning probability of 70%
bo3_sim <- game_sim(5000, 0.7, 3)
bo3_plot <- ggplot(data = bo3_sim, aes(x = index, y = probability)) +
     geom_line() +
        labs(title="BO3 with Korean 70% chance winning a single game",
            y ="Probability of Victory", x = "Number of Games Simulated") +
        theme_minimal()

bo3_plot
```




```
# A simulation of a bo5 with winning probability of 70%
bo5_sim <- game_sim(5000, 0.7, 5)
bo5_plot <- ggplot(data = bo5_sim, aes(x = index, y = probability)) +
     geom_line() +
        labs(title="BO5 with Korean 70% chance winning a single game",
            y ="Probability of Victory", x = "Number of Games Simulated") +
        theme_minimal()

bo5_plot
```



We can verify these two results using a deterministic approach, and it turns out that the winning chance for BO3 and BO5 are 78.4% and 83.7% respectively.

```
bo3_vic_prob_1 <- 1 - (choose(3,0) * 0.7^0 * 0.3^3 + choose(3,1) * 0.7^1 * 0.3^2)
bo5_vic_prob_1 <- 1 - (choose(5,0) * 0.7^0 * 0.3^5 + choose(5,1) * 0.7^1 * 0.3^4 + choose(5,2) * 0.7^2 *
bo3_vic_prob_1
```

```
## [1] 0.784
```

```
bo5_vic_prob_1
```

```
## [1] 0.83692
```

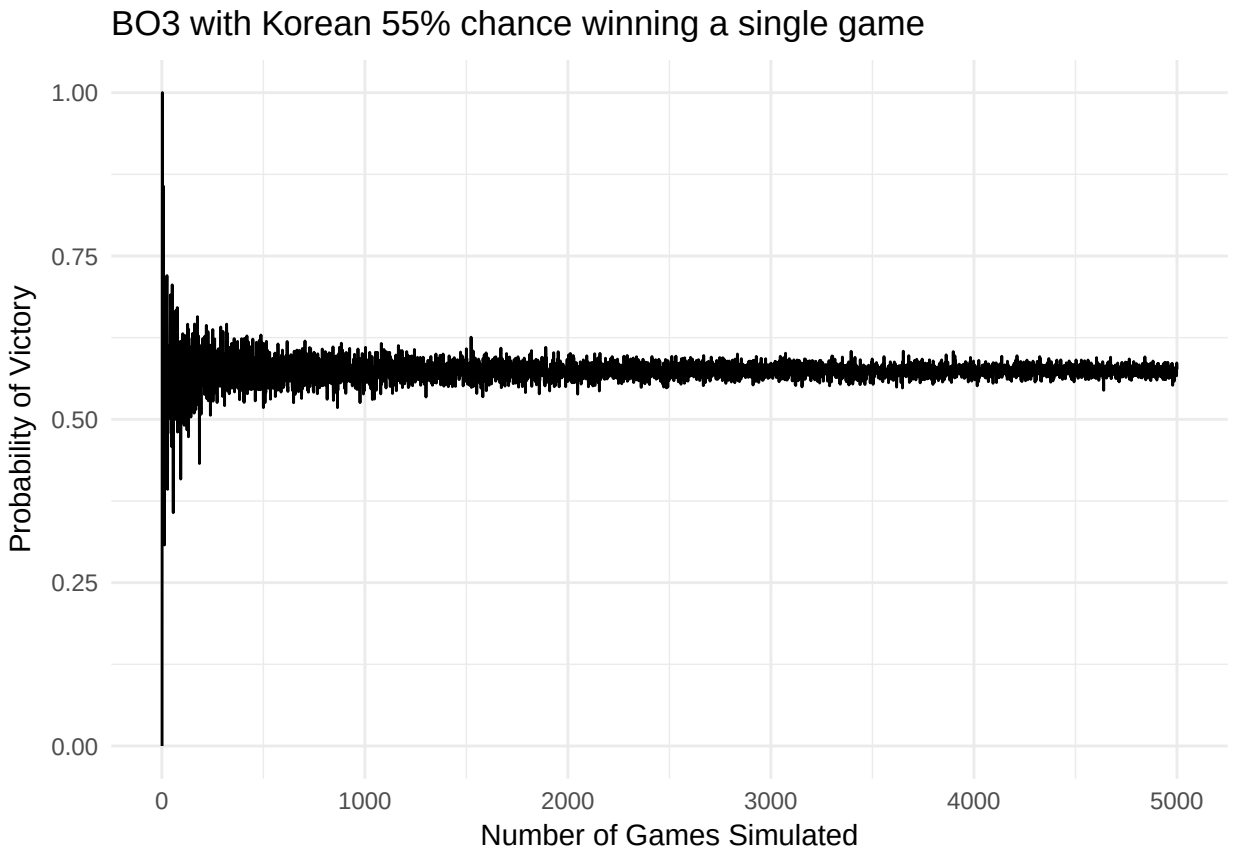
Second simulation: Will the non-Korean teams have a better chance?

Right, but teams from other regions have been constantly improving, and the gap is definitely shrinking. With this being noticed, will they ave a better shot to win, say in the upcoming 2018 Mid-Season Invitation? Let's see what will happen if the probability of Korean team winning one single match drops vastly from 70% to 55%.

```
# A simulation of a bo3 with winning probability of 55%
bo3_sim_2 <- game_sim(5000, 0.55, 3)
bo3_plot_2 <- ggplot(data = bo3_sim_2, aes(x = index, y = probability)) +
     geom_line() +
        labs(title="BO3 with Korean 55% chance winning a single game",
            y ="Probability of Victory", x = "Number of Games Simulated") +
```

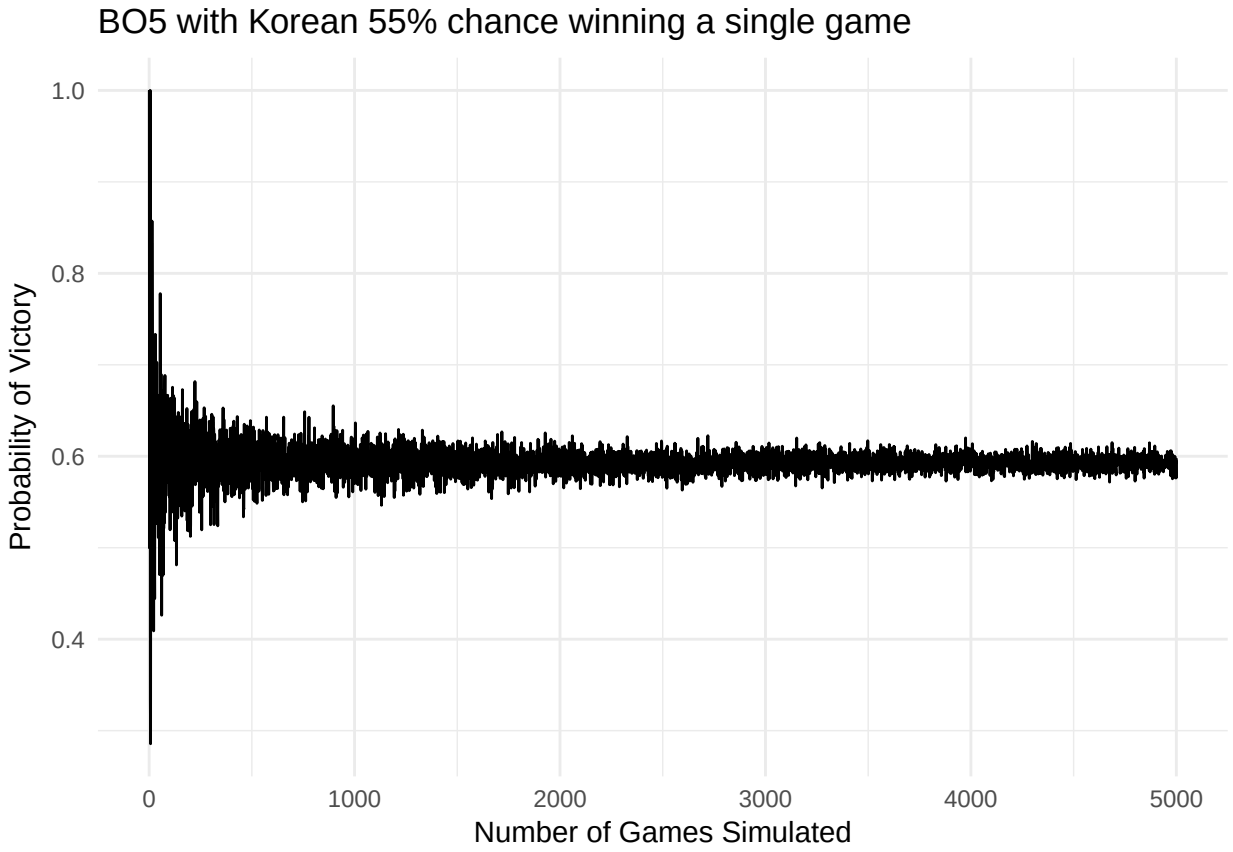
```
        theme_minimal()

bo3_plot_2
```




```
# A simulation of a bo5 with winning probability of 55%
bo5_sim_2 <- game_sim(5000, 0.55, 5)
bo5_plot_2 <- ggplot(data = bo5_sim_2, aes(x = index, y = probability)) +
     geom_line() +
        labs(title="BO5 with Korean 55% chance winning a single game",
            y ="Probability of Victory", x = "Number of Games Simulated") +
        theme_minimal()

bo5_plot_2
```




```
bo3_vic_prob_2 <- 1 - (choose(3,0) * 0.55^0 * 0.45^3 + choose(3,1) * 0.55^1 * 0.45^2)
bo5_vic_prob_2 <- 1 - (choose(5,0) * 0.55^0 * 0.45^5 + choose(5,1) * 0.55^1 * 0.45^4 + choose(5,2) * 0.5
bo3_vic_prob_2
```

```
## [1] 0.57475
```

```
bo5_vic_prob_2
```

```
## [1] 0.5931269
```

Using the same approach, unfortunately, we found Korean team still have almsot 60% chance to win games (57.5% for BO3 and 59.3% for BO5). They will not be as dominationg, yet we can still claim that the odds still strongly favor Korean teams.

So what did we learn?

In this simulatin problem, what we are really discussing is that if we know a team has a higher probability to win a single match, what is the probability of that team winning a BO5 match. More importantly, what can the relationship between these two probabilities tell us?

- For Leagues Players:
  - As we saw, as long as Korean teams have a higher probability to win a single match (even as slight as 55 percent), this probability will eventually be enlarged for a BO5 series. This is why BO5 is introduced to most of the international tournaments: the more games are played, the more likely the better team will win the trophy. Within the same logic, miracle 8th seeds were so rare in the NBA playoffs history, yet we are able to see there are so many upset games in NFL playoffs.

  - In order to take over major titles from LCK, the only way for teams from other regions is to improve their overall competitiveness in every aspects from mechanics to team synergy. Differen patches or interesting ban/pick might give you temporal victory, but will never win you any title.
- For Data People
  - Through this simple example, we have seen that we can break down seemingly complicated real life problems into statistics models, then study them analytically.
  - Simulation is more powerful that most people think. It is usually true that more data leverages more insights, but simulation gives us an alternative when we have almost no data at all.
  - Simulation is also very flexible: we can just pick individual motions that will lead to different outcomes, and let the machine do the work for you.