Project 1 Martingale:
CS7646

Abel Aguilar
aaguilar61@gatech.edu

QUESTION 1:

The given probability of winning any particular spin is 47.4% in American Roulette (Wikimedia Foundation, 2022). What are the experimental odds of winning 80 dollars with an unlimited bankroll using the Martingale method? After running 10 experiments, my winnings after each of the 10 episodes reached 80 dollars given that there is an unlimited bank role. Figure 1 demonstrates this below:

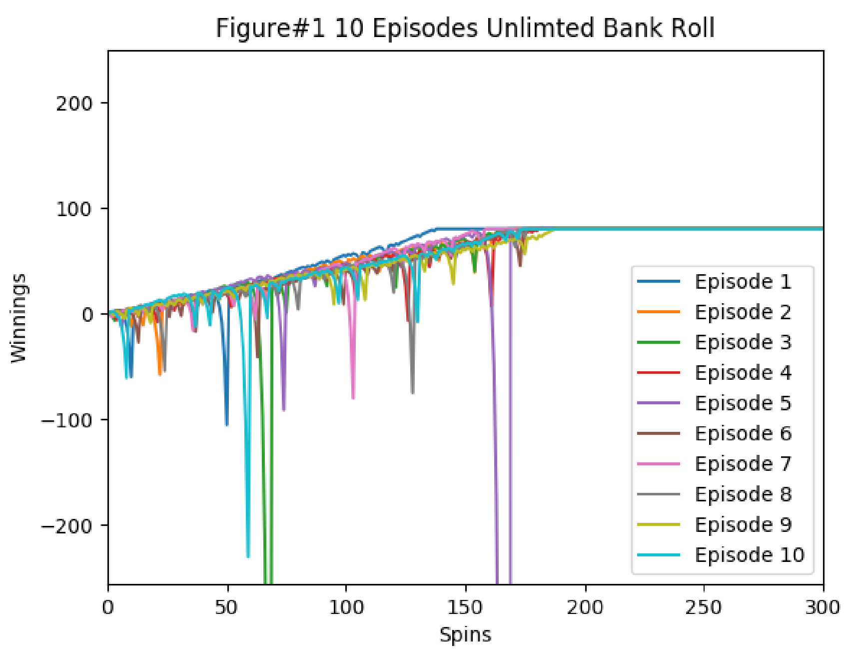

Figure 1 - 10 Episodes all reaching 80 dollars after roughly 180 spins. This is with an unlimited bankroll

This fact held true after running 1000 episodes, every single one of these episodes reached 80 dollars in winning. This gives us a probability of 100% or 1. This also fits with our theoretical approach to this problem given the way Martingale works. If a player wins 80 total spins, they win since any time a win occurs our player wins all their loses back plus 1 dollar. This can be shown as a Binomial Distribution (NIST). Shown in Figure BD.

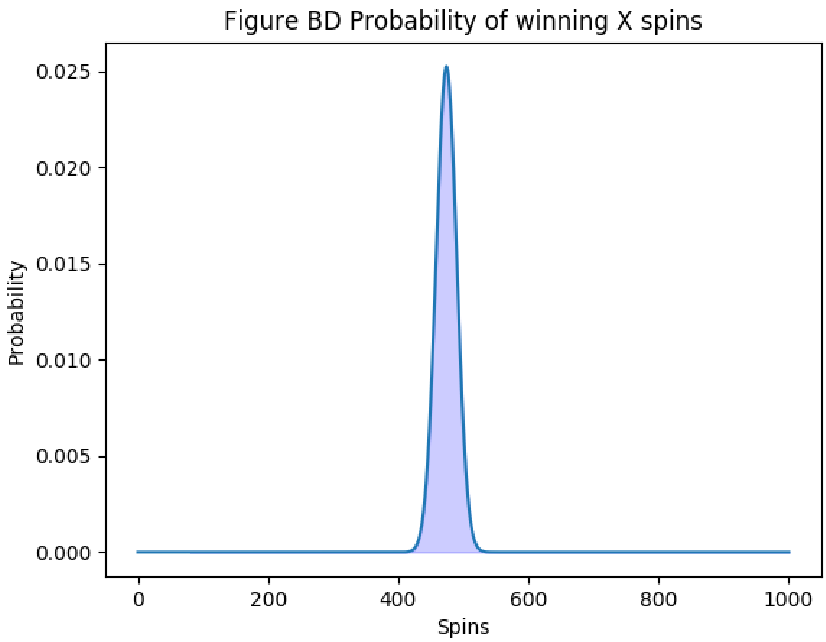

Figure BD - Binomial Distribution of 1000 spins given a P=0.474. Probability of winning at least 80 times is the area under the curve from 80 <= x <=1000

The theoretical chance of winning 80 dollars with an unlimited bankroll and 1000 spins is 1 - 1.4064367840477154e-163 or approximately 1. This matches our experimental data.

QUESTION 2:

Our expected value of winnings is 80 dollars. Since there is approximately a 100% chance of winning with an unlimited bankroll, all 1000 experiments will reach 80 dollars making our average winnings 80 dollars at the end of 1000 spins. This can be seen in Figure 2. Figure 3 shows that our median also reached 80 dollars for the same reason.

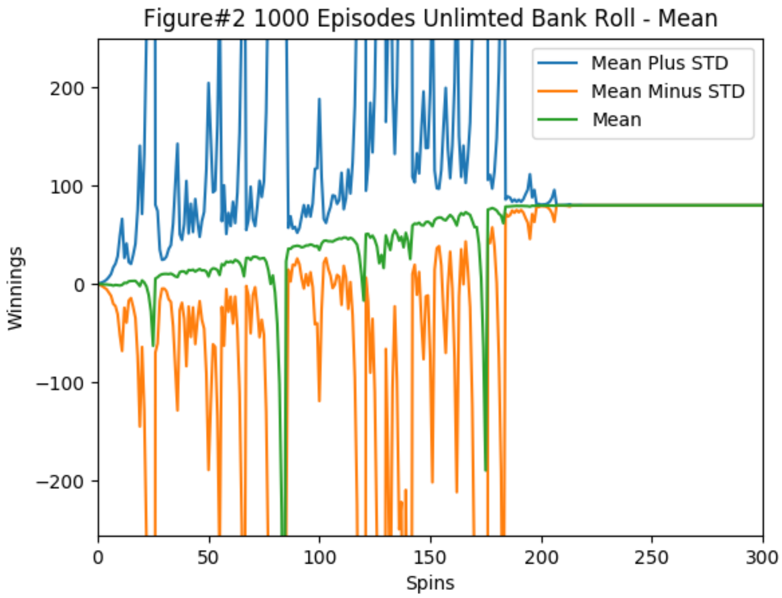

Figure 2 - 1000 Episodes all reaching 80 dollars This is with an unlimited bankroll. Mean stabilizes at 80

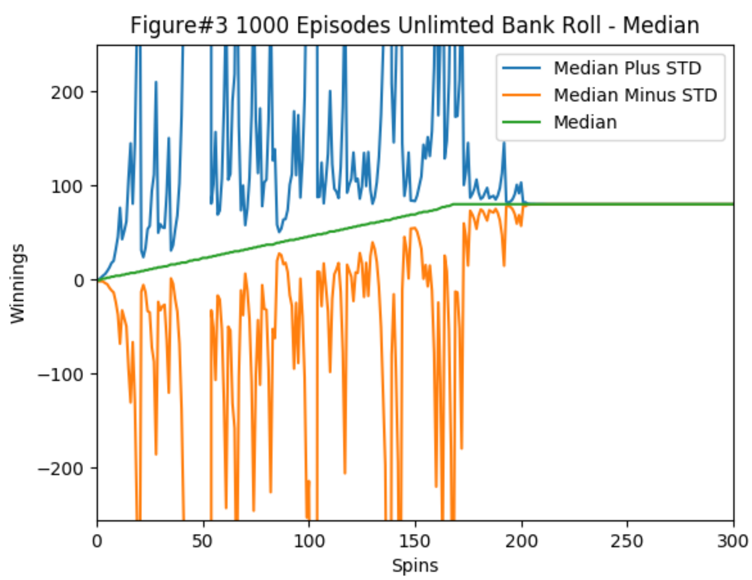

Figure 3 - 1000 Episodes all reaching 80 dollars This is with an unlimited bankroll. Median stabilizes at 80

QUESTION 3:

The mean + standard deviation reaches a maximum value of ~16079.745, and our mean - standard deviation reaches a minimum of ~-17081.333. These lines stabilize and converge at 80. This is because all episodes reach 80 dollars, thus the variance becomes 0 so the mean (80) minus/plus the standard deviation (0) leaves all lines at 80.

QUESTION 4:

According to my experimental data the probability of winning 80 dollars with a bankroll of 256 dollars is roughly 65%. This is because out of 1000 episodes, 650 won 80 dollars and 350 lost 256 dollars.

QUESTION 5:

The expected value is -37.6. This is because their is larger number of wins then losses, 65% of the time the player wins and 35% the player loses, this is why the average is closer to 80 then -256. -37.6 is the average after 1000 spins.

QUESTION 6:

The mean + standard deviation reaches a maximum value and stabilizes at ~122.857, and our mean - standard deviation reaches a minimum value and stabilizes at ~-197.941. The reason both these values stabilize is because after about 180 spins all episodes finish and reach the value they will be staying at for the rest of the episode. This means the variance are no longer changing. These lines do not converge on a line because the variance is not 0. Because their not 2 possible outcomes 80 dollars or -256 dollars the variance can never reach 0 thus the lines do not converge unlike those in Figure 2 and 3 which only had 1 outcome. This can be seen in Figure 4 and Figure 5.

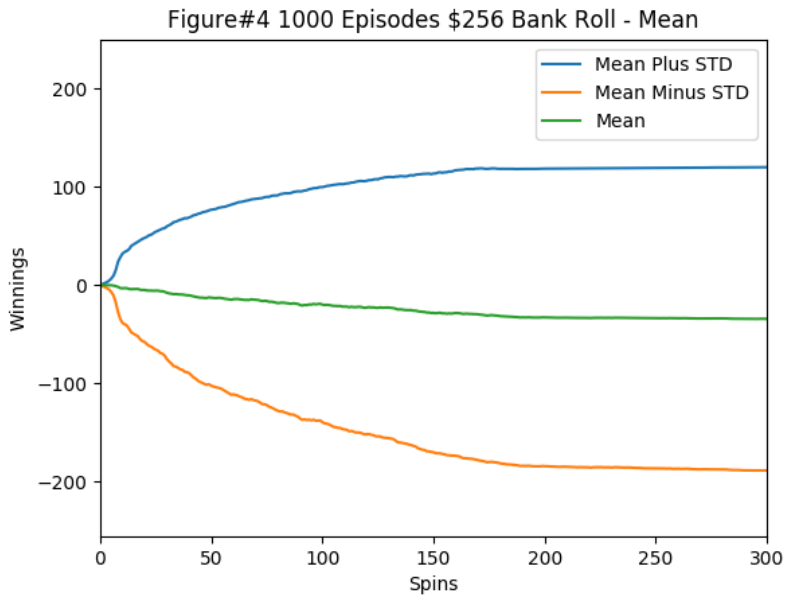

Figure 4 - 1000 Episodes with an expected value of -37.6. This is with an 256 dollar bankroll

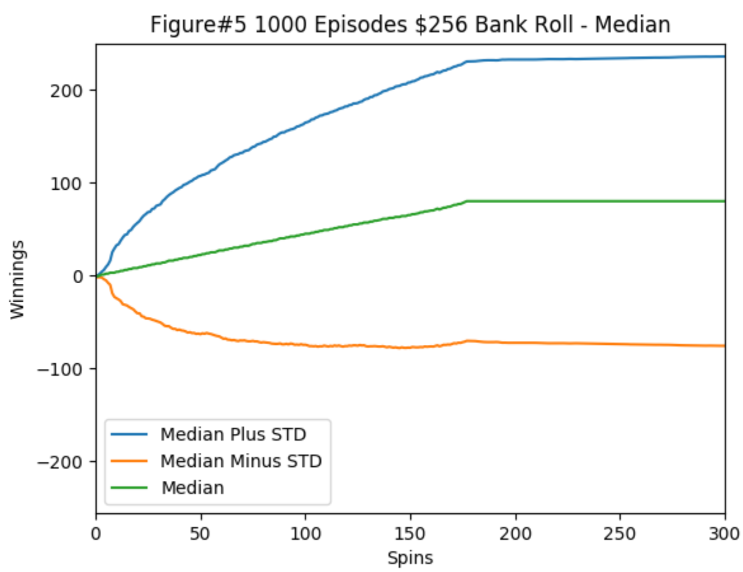

Figure 4 - 1000 Episodes with an median of 80. This is with an 256 dollar bankroll

QUESTION 7:

The benefits of using an expected value rather than simply using the results from one experiment is that one experiment can be skewed is some way. An outcome with a very rare probability could occur on in one experiment and that would not be realistic for most cases. An average of many experiments ensures us that we see the most likely outcome many times and allows us to account for that in our data.

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