

Report: CS ML4T Assignment 1 Martingale  
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1.  $P(\text{Winning \$80 within 1000 bets for simple simulator}) = 1$   
Probability based on running 1000 simulations and getting to \$80 by around 200 bets every time with a standard deviation that is converging to 0. See Figure 1 and 2 below.

Figure 1: Simple Simulator 10 Simulations

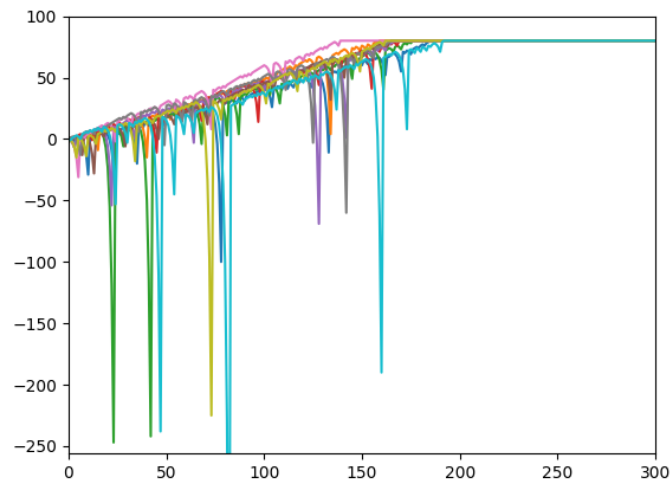


Figure 2: Mean for 1000 Simulations of Simple Simulator

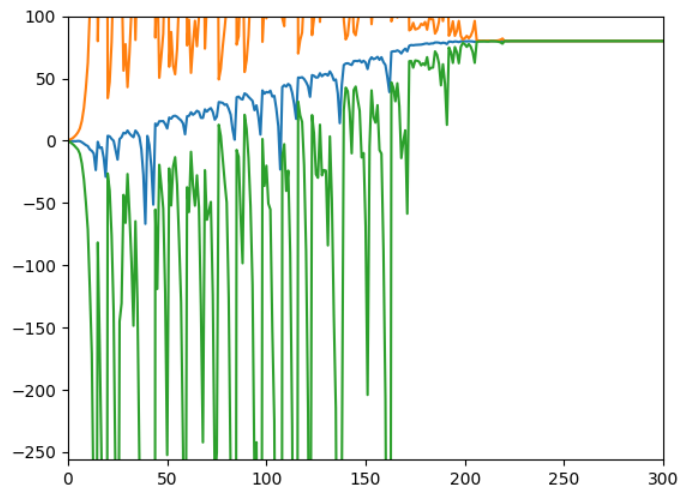
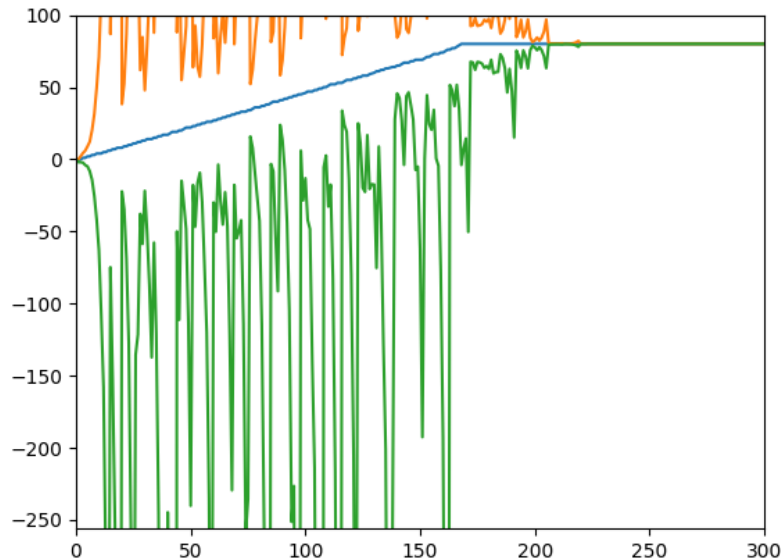


Figure 3: Median for 1000 simulations of the Simple Simulator



2. Expected Value of winnings after 1000 bets for simple simulator = \$80  
Based on Figures 1 and 2 above, where Figure 2 represents the mean for 1000 simulations. It is clear that the value reaches 80 with no deviation after around 200 bets.

3. Yes for experiment 1 the standard deviation converges to a value of 0 after around 200 bets, as shown by Figure 2 above. The value of  $x$  reaches the expected value of 80 for each simulation and thus  $SD = 0$ .

4. Two different methods used for calculating the probability of reaching \$80 within 1000 bets for the realistic simulator. First by counting the number of times 80 is reached for a 100 simulations of the simulator and Second using a weighted mean formula assuming the values reach either -256 or 80 by a 1000 bets, using the formula below:

$$(-256(1-x) + 80x)/2 = -30$$
 (Mean reached after 1000 simulations; shown in Figure 4)

using both methods, a Probability of around 0.59 is found.

This also agrees with Figure 5, where the median reaches 80 after around 200 bets, meaning that 80 was most the common value (greater than 50 % probability at least) after 200 bets in all the 1000 simulations run.

Figure 4: Mean after 1000 Simulations of Realistic Simulator

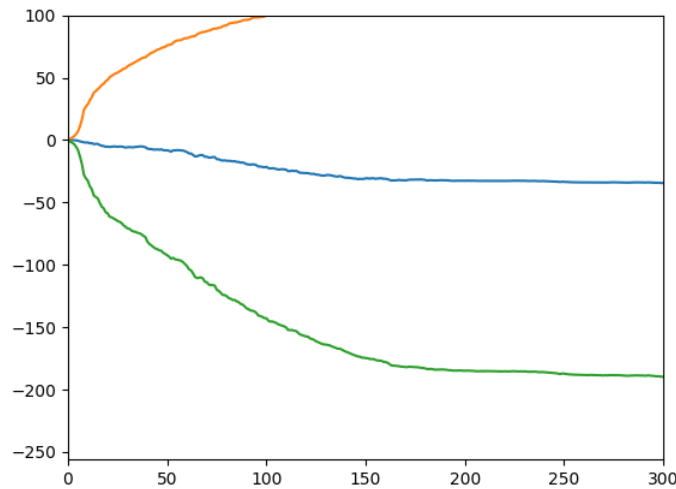
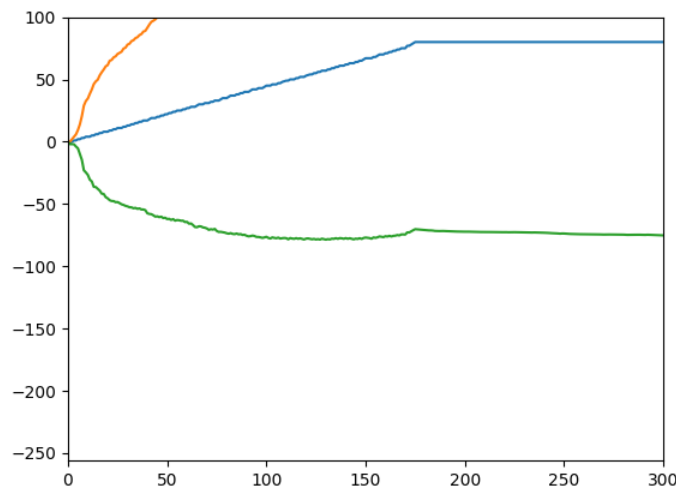


Figure 5: Median after 1000 simulations of Realistic Simulator



5. Expected Value after 1000 bets for realistic Simulator = -30  
Based on Figure 4 (Mean for 1000 simulations of Realistic Simulator). Value will vary slightly based on initial random seed provided.

6. As seen in Figures 4 and 5, after around 200 bets, the standard deviation stabilizes to a value of about 150, which is around halfway between 80 and -256 since for most runs, the simulator either goes to -256 ( $P(\text{for } -256) \sim 0.4$ ) or 80 ( $P(\text{for } 80) \sim 0.6$ ). This is unlike the simple simulator which always reaches 80 and thus the Standard deviation converges to 0.

