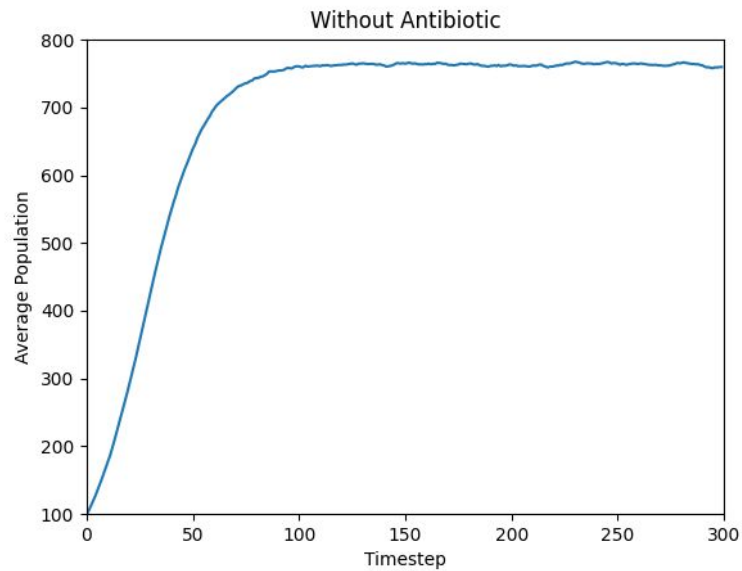


Problem Set 4:

Simulating the Spread of Disease and Bacteria Population Dynamics

[random seed = 0]

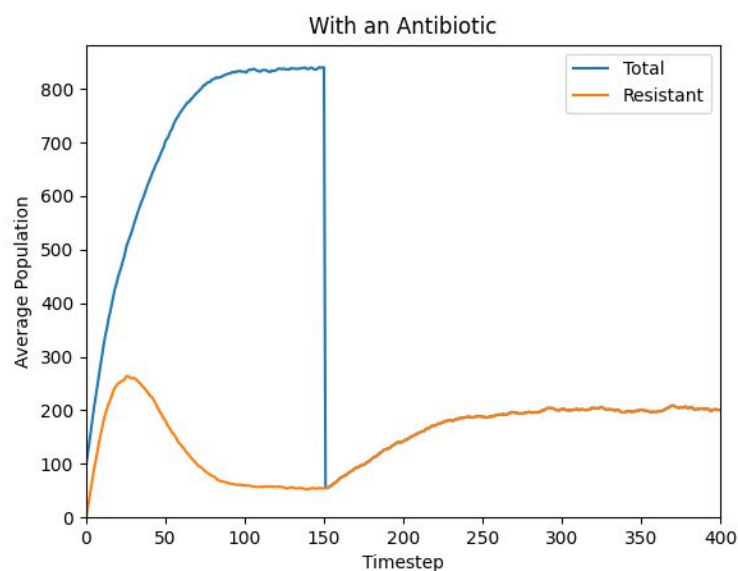
Problem 2: Running and Analyzing a Simple Simulation (No Antibiotic Treatment)



Problem 3: Calculating a Confidence Interval

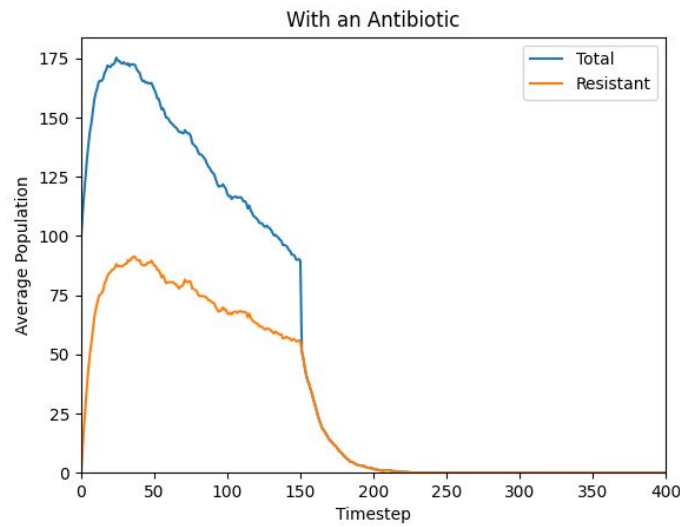
95% confidence interval: 759.540 +/- 4.213

Problem 5: Running and Analyzing a Simulation with an Antibiotic Simulation A



95% confidence interval: 200.580 +/- 7.686

Simulation B:



95% confidence interval: 0.100 +/- 0.194

Problem 6: Write-up

1. What happens to the total population before introducing the antibiotic?

In simulation A, the average total population escalates quickly, then reaches its peak and plateaus at a high level (around 820 to 840) at timestep 90 until the introduction of the antibiotic. However, in simulation B, the average population first has a little increase, followed by a steep drop back to the starting position. This can be explained by the birth rate of bacteria B is much lower than that of A (A: 0.3, B: 0.17) while having the same death rate (0.2).

2. What happens to the resistant bacteria population before introducing the antibiotic?

In both simulations, their resistant bacteria populations follow a 'first-rise-then-drop' trend. However, as bacteria in simulation A has a higher birth rate, it reaches a higher peak than bacteria in simulation B.

3. What happens to the total population after introducing the antibiotic?

In both simulations, as the antibiotic is introduced, their total populations plunge sharply and overlap with the antibiotic resistant bacteria population, which shows that all bacteria with no resistant to antibiotic vanish.

4. What happens to the resistant bacteria population after introducing the antibiotic?

The resistant bacteria population after introducing the antibiotic act differently in simulation A and B. In A, since the natural birth rate is higher than its natural death rate, it rises gradually and fluctuates around 200. On the contrary, as the birth rate is lower than the death rate, the resistant bacteria population continues to decline gradually and reach zero at around 250 timestep.