6.0002 MIT OCW Fall 2016

Problem Set 4 Write-Up

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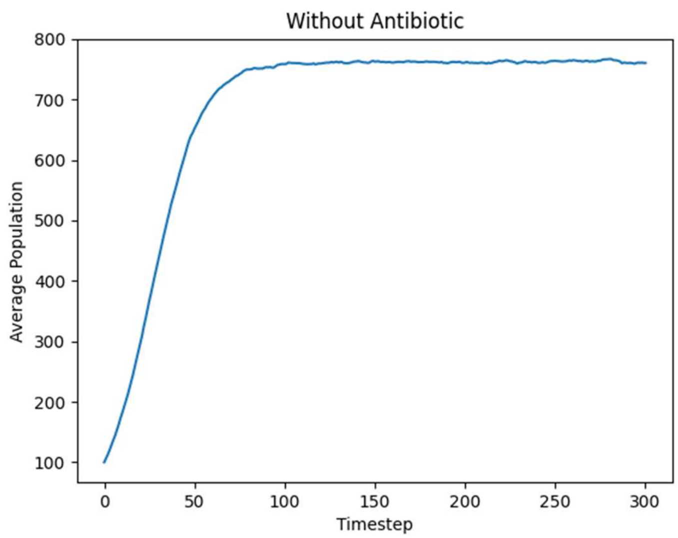
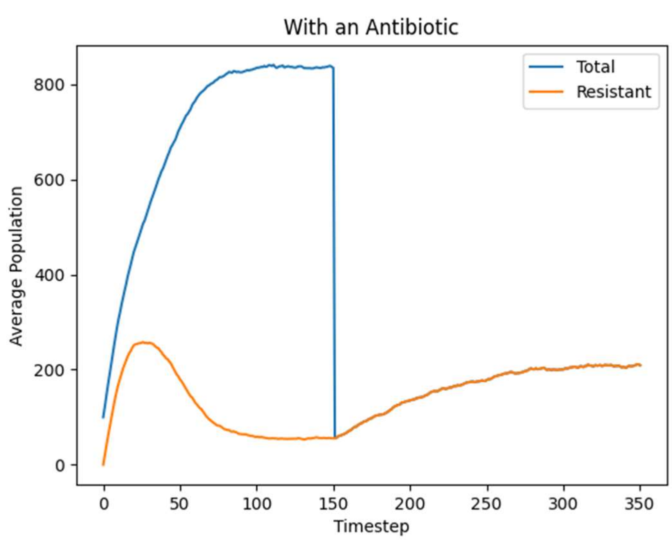
Problem 2 Simulation



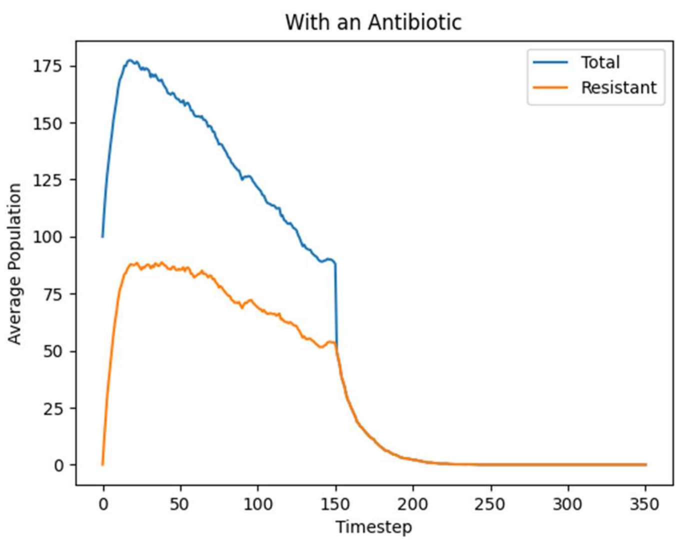
Problem 5 Simulation A



1. Before introducing the antibiotic, the total population grows at a decreasing rate, reaching what appears to be a carrying capacity. This is because the bacteria's reproduction probability decreases with increasing population density.

2. The resistant bacteria population increases, and then reaches a maximum before decaying at a decreasing rate. This is because the probability of non-resistant bacteria developing a resistance also decreases with increasing population density, so fewer and fewer new resistant bacteria are generated, until their population declines again to a stable limit.
3. After introducing the antibiotic, the total bacteria population drops sharply since the non-resistant bacteria are killed, leaving only the remaining resistant bacteria.
4. After introducing the antibiotic, the resistant bacteria population begins increasing again, because the sudden drop in total population drastically decreases the population density, increasing the likelihood of reproduction.

Problem 5 Simulation B



1. Before introducing the antibiotic, the total population rises sharply to a maximum, before decreasing at a mostly consistent rate. This is because the death probability is higher relative to the birth probability, so in expectation, bacteria are decreasing in numbers.
2. The same as above is true for the resistant population before introducing the antibiotic.
3. After introducing the antibiotic, the total population drops sharply, because only the remaining resistant bacteria survive.
4. After introducing the antibiotic, the resistant population also begins to drop at an initially higher rate, before decaying gradually to zero. This is because their death probability is still higher than their birth probability, despite being resistant to the antibiotic.