The Common Cold: SIS “Susceptibles vs. Infected” Model

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# Abstract

In this study, we set out to create an SIS “Susceptibles vs. Infected” Model of the common cold over a 6-day period. The goal was to find the steady state of the dynamical system given the rate of infection, fixed population, and rate of recovery for the common cold. The common cold is a type of disease in which once recovered, a person is susceptible to infection again. Although the problem could be modeled using a discrete dynamical system, the objective required that we use a continuous dynamical system. We used sage/python to model and analyze this problem. Once modeled, finding the equilibrium points to the system is the next step as it shows the value in which the model reaches its steady state. Reaching the steady state (finding the equilibrium points) indicates that the recently observed behavior of the system will continue into the future. What that means for this problem is that we’ll expect the number of cases to converge to a point and remain there, or at least this is what we believe. Finally, we were interested the reproductive number as it will tell us if the disease will spread and approach the steady state or if it will eventually reach the disease-free state. As this is an SIS model we expect to the reproductive number to be greater than 1, indicating that it will reach the steady state.

# Introduction

The common cold, as the name suggests, is a very common disease that afflicts millions in the United States every year. Scientist model disease in order to determine how the disease will affect large populations, and potentially offer treatment. Infection Rates, Recovery Rates, Reproductive numbers are all important in determining how the common cold will affect large populations and determine whether treatment is necessary amongst these populations. For this report, our goal is to determine if the disease will reach the steady state; We’ll determine if the disease will persist. In order to do that we create a continuous dynamical system, where we have growth rate and competition term. We’ll be looking to find the equilibrium points of the system as that will determine the steady state of the system; This will be shown graphically. From there we’ll look for the reproductive number as that will also determine if the disease will spread and approach the steady state.

# Assumptions and Definitions

For the model of the continuous dynamical model, we’ll assume the following:

* where
* where
* where

The Total Population, , is a fixed population of 10000 people. The number of Infected, , is given to be 120 members of the total population. Number of Susceptibles, , is equal to 9880 members of the total population. This is reasonable due to the model not having in between cases; You’re either Susceptible or Infected. Infection Rate is,, is given to be 85% or 0.85. The Recovery Rate is,, is assumed to be as the duration is given to be 6 days. We also assume that as we cannot have negative population. We also need to know that a differential equation (e.g.: , ) simply relates the rate of change (derivate) to the state variables. To solve the model, we’ll be using a computer algebra system such as Sage-math or Python with its numerous symbolic, numerical, and scientific libraries.

# Analysis

To solve the system, we set both differential equations to 0. This is because if the rate of change is 0, it means there is no change and the dynamical system has reached his steady state.