**Exercise 2.2**

**I am legend**

90% infected -> died

9% infected -> mutant

1% infected -> recover with immunity

Mutants can kill human, being kill by human or transmit the disease

**First scenario**

b = birth rate

d = natural death rate

β = transmission rate

σ = rate of human kill by mutant

n = rate of mutant kill by human

i = rate of mutant kill by immune person

µ = recovery rate = 0,01

z = rate of deaths because of the disease = 0.9

m = rate of transformation into mutant =0.09

= bS – dS – βSI – SM(1- σ -n) – σSM

= βSI + SM(1- σ -n) – (µ +d +z + m)I

= Im – nSM - iRM

= µI – dR - σRM

Susceptible population will increase with births and decrease with deaths, infection because of the interactions with infected population, infection because of the interactions with mutants and deaths because interactions with mutants.

Infected population will increase because of the interactions with susceptible population and the infected humans because of interactions with mutants, and will descend by recovery rate, natural death, infection death and transformation into mutant.

Mutant population will increase by the transformation rate of infected population and decrease because can be kill by not infected humans.

Immune population will increase by recovery rate of the infected population and die by natural death or interaction with mutants

Interfaz de usuario gráfica, Aplicación

Descripción generada automáticamente

S = 500, I = 10, M = 10, R = 5, b = 0.4, d = 0.2, β = 0.0008, σ = 0.4, n = 0.3, i = 0.6, µ = 0,01, z = 0.9, m =0.09

With this parameter we can see how we have three cycles of infections, in the third one the mutant population increase, and the infected and susceptible population decrease to zero, so we only have the immune and mutant population, being the immune population almost zero.

Studying the infected population´s differential equation we obtain that in order to have evolution of the infection. S0 >

If we want the mutant population to disappear, the next condition must be met,

Im = M(nS -iR), so it is not possible to get ride of mutant population because they are going to appear when susceptible population is decreasing and infected population is decreasing, and when we have this condition the immune population that can get ride of the mutant population is very low because µ = 0,01 and the mortality rate is very high so there are no people to fight the mutant.

Interfaz de usuario gráfica, Aplicación

Descripción generada automáticamente

**Second scenario**

Now not infected humans can turn mutants into people

b = birth rate

d = natural death rate

β = transmission rate

σ = rate of human kill by mutant

n = rate of mutant kill by human

i = rate of mutant kill by immune person

t = transformation of mutants into susceptible population

µ = recovery rate = 0,01

z = rate of deaths because of the disease = 0.9

m = rate of transformation into mutant =0.09

= bS +SMt + RMt – dS – βSI – SM(1- σ -n) – σSM

= βSI + SM(1- σ -n) – (µ +d +z + m)I

= Im – nSM – iRM – SMt -RMt

= µI – dR – σRM

Interfaz de usuario gráfica

Descripción generada automáticamente

S = 500, I = 10, M = 10, R = 10, b = 0.4, d = 0.2, β = 0.0008, σ = 0.4, n = 0.3, i = 0.6, t =0.2, µ = 0,01, z = 0.9, m =0.09

The result obtained is similar as before because the problem is that the mutant population doesn’t appears until the susceptible population is low enough so when they appear the infected population is very high and most of this population will die. Moreover the immune population is almost non-existent, even if we increase its initial number because they die before the mutant population arise.

Interfaz de usuario gráfica, Aplicación

Descripción generada automáticamente