SIR model with mortality(frequency-dependent)

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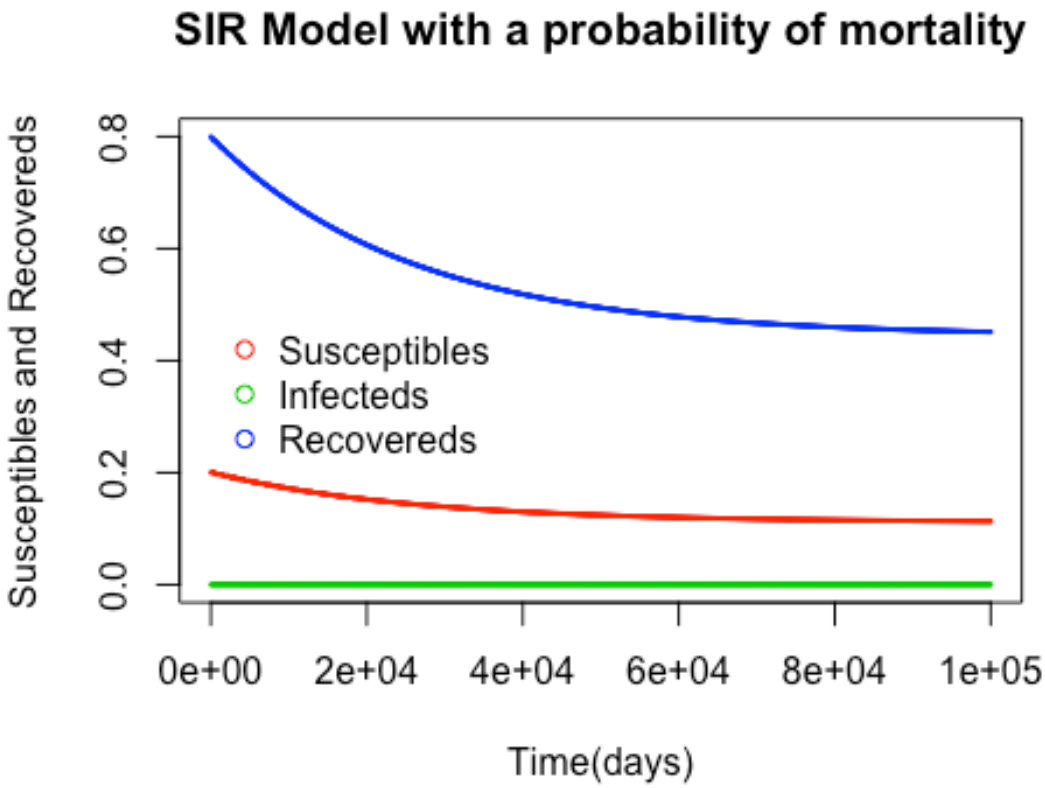
## It is the SIR model with a probability of mortality, and uneuqal births and
deaths.
## This code assumes Frequency-Dependent Transmission

## Parameters:
# rho: The mortality probability;
# nu: The population level birth rate;
# miu: Per captia death rate, and the population level birth rate;
# beta: Product of contact rates and transmission probability;
# gamma: Recovery Rate;
# X: The number or density of susceptible individuals;
# Y: The number or density of infectious individuals;
# Z: The number or density of recovered individuals.
library(deSolve)

SIR.freq = function(time, state, pars) {
  with(as.list(c(state,pars)), {
    dX = nu - beta * X0 * Y0 / (X0 + Y0 + Z0) - miu * X0
    dY = beta * X0 * Y0 / (X0 + Y0 + Z0) - (gamma+miu)/(1-rho) * Y0
    dZ = gamma * Y0 - miu * Z0
    return(list(c(dX,dY,dZ)))
  })
}
# condition 1
yini = c(X0 = 0.2,Y0 = 1e-4,Z0 = 1-0.2-1e-4)
pars = c(rho = 0.5, nu = 1/(70*365), miu = 1/(70*365), beta = 520/365,gamma =
1/7)
times = seq(0,1e5,by = 1)


out = ode(func = SIR.freq, y = yini, parms = pars, times = times)
out = as.data.frame(out)
out$time = NULL

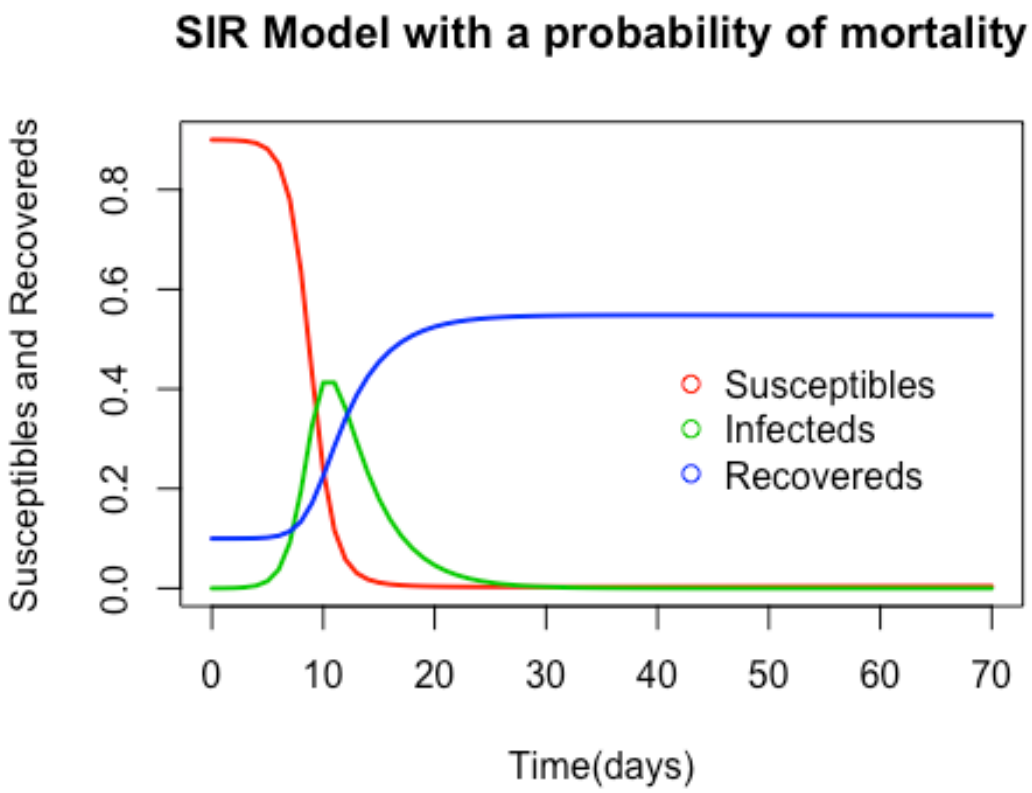
matplot(times,out,type = "l", xlab = "Time(days)", ylab = "Susceptibles and
Recovereds", main = "SIR Model with a probability of mortality",
        lwd = 2, lty = 1, col = 2:4)
legend(40,0.5,c("Susceptibles","Infecteds","Recovereds"), pch = 1, col =
2:4,bty = "n")
```


SIR Model with a probability of mortality
Susceptibles and Recovereds
0.0
0.2
0.4
0.6
0.8
Susceptibles
Infecteds
Recovereds
0e+00
2e+04
4e+04
6e+04
8e+04
1e+05
Time(days)

```r
# condition 2
yini = c(X0 = 0.9,Y0 = 1e-4,Z0 = 1-0.9-1e-4)
pars = c(rho = 0.5, nu = 1/(70*365), miu = 1/(70*365), beta = 520/365,gamma =
1/7)
times = seq(0,70,by = 1)


out = ode(func = SIR.freq, y = yini, parms = pars, times = times)
out = as.data.frame(out)
out$time = NULL

matplot(times,out,type = "l", xlab = "Time(days)", ylab = "Susceptibles and
Recovereds", main = "SIR Model with a probability of mortality",
        lwd = 2, lty = 1, col = 2:4)
legend(40,0.5,c("Susceptibles","Infecteds","Recovereds"), pch = 1, col =
2:4,bty = "n")
```



```r
# condition 3
yini = c(X0 = 0.9,Y0 = 1e-4,Z0 = 1-0.9-1e-4)
pars = c(rho = 0.5, nu = 1/(70*365), miu = 1/(70*365), beta = 520/365,gamma =
1/7)
times = seq(0,1e5,by = 1)


out = ode(func = SIR.freq, y = yini, parms = pars, times = times)
out = as.data.frame(out)
out$time = NULL

matplot(times,out,type = "l", xlab = "Time(days)", ylab = "Susceptibles and
Recovereds", main = "SIR Model with a probability of mortality",
        lwd = 2, lty = 1, col = 2:4)
legend(6e4,0.8,c("Susceptibles","Infecteds","Recovereds"), pch = 1, col =
2:4,bty = "n")
```