Untitled

me

2024-06-12

R Markdown

```
rm(list = ls())
```

We computer our Beta with respecte to R0 and our parameters

```
beta.calc <- function(Ro,mu=0.02/365.25,sigma=1/8,gamma=1/5){
  Ro/((sigma/(mu+sigma))*(1/(mu+gamma)))
}
```

We set up our seir model be including nu the birth rate and p the vaccination proportion. By add the proportion of the new birth that were not vaccinated to the susceptible compartment and the vaccinated proportion to the Recovered compartiment. we define the time (t) the number of years we are interest in simulating. We use linear ODE solver from R's deSolve to solve iterative over the number of days in t and computed the value of all compartment at each iteration.

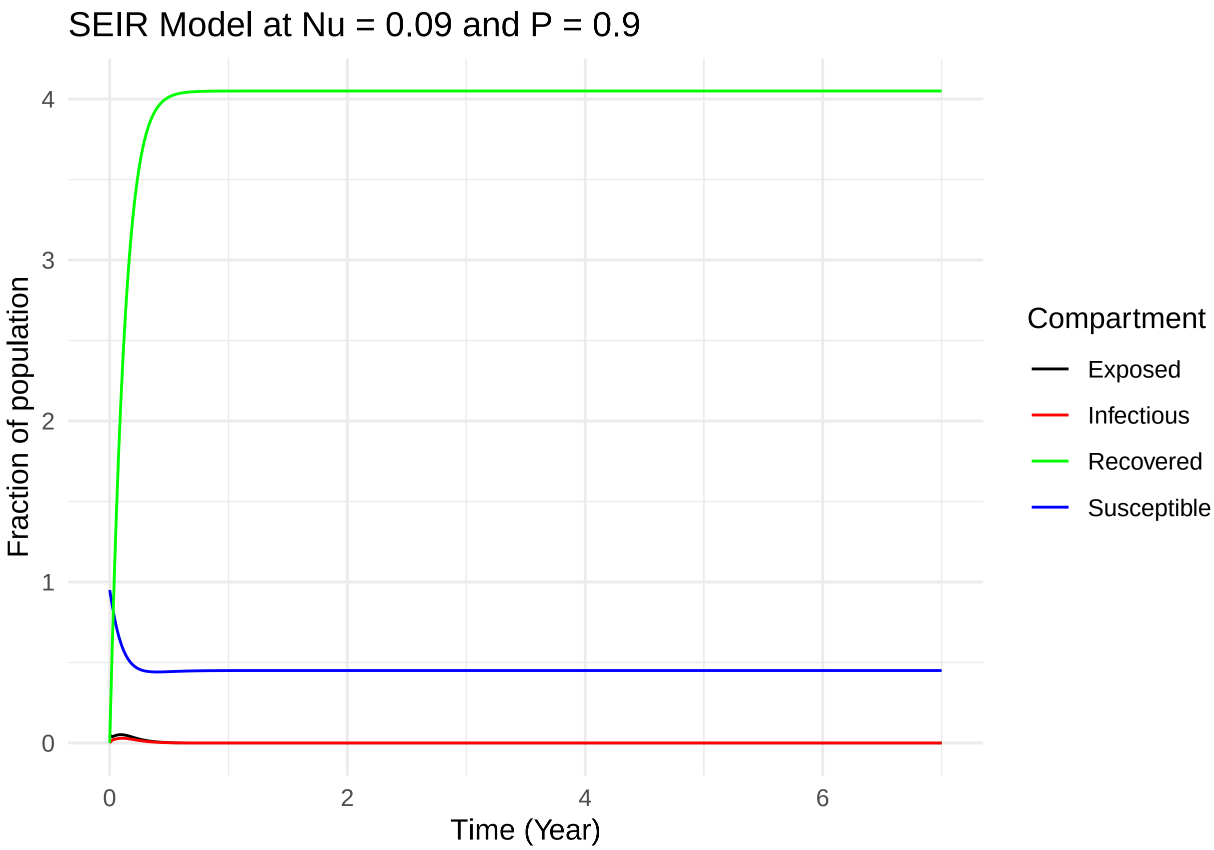
```
# Load necessary libraries
library(deSolve)  # for ode solving
library(ggplot2)  # for plotting
library(glue)

# Define SEIR model function with seasonal transmission rate
SEIR_model <- function(time, state, parameters) {
  with(as.list(c(state, parameters)), {
    beta_t <- beta_0 * (1 + A * sin(2 * pi * time / T))
    inc <- sigma * E
    N <- S +E + I + R
    dS_dt <- nu*(1-p) - ((beta_t * I )/N + mu) * S
    dE_dt <- beta_t * S * I - (sigma + mu) * E
    dI_dt <- sigma * E - (gamma + mu) * I
    dR_dt <- (nu * p )+ gamma * I - mu * R
    return(list(c(dS_dt, dE_dt, dI_dt, dR_dt,inc)))
  })
}


# Time points (in days)
t <- seq(0,7*365,1)
N0 <- 1
```

For study, we consider different values of nu and p and simulate the with the model and observer the interaction of each compartment. The aim is know what proportion of the new birth need to be vaccinated in order to achieve a disease free equilibrium.

```r
# Initial conditions
initial_state <- c(S = N0 * 0.95, E = N0 * 0.05, I = N0 *0, R = N0 *0, inc = 0)

# Parameters
parameters <- list(
  beta_0 = beta.calc(2),
  A = 0.08,
  T = 365,  # Period of one year in days
  sigma = 1/8,
  gamma = 1/5,
  nu = 0.09 * N0 ,
  mu = 0.02,
  p = 0.9,
  N = N0

)

# Solve the SEIR equations
output <- ode(y = initial_state, times = t, func = SEIR_model, parms = parameters)

# Convert output to data frame for plotting
output_df <- as.data.frame(output)
weekly.report <- output_df[seq(1, nrow(output_df), by = 7),]
```

```r
plot.param <- function(weekly.report){
# Plotting using ggplot2
ggplot(weekly.report, aes(x = time/365)) +
  geom_line(aes(y = S, color = "Susceptible")) +
  geom_line(aes(y = E, color = "Exposed")) +
  geom_line(aes(y = I, color = "Infectious")) +
  geom_line(aes(y = R, color = "Recovered")) +
  labs(x = "Time (Year)", y = "Fraction of population", color = "Compartment") +
  ggtitle(glue("SEIR Model at Nu = {parameters['nu']} and P = {parameters['p']}")) +
  theme_minimal() +
  scale_color_manual(values = c("Susceptible" = "blue", "Exposed" = "black", "Infectious" = "red", "Rec
}
```

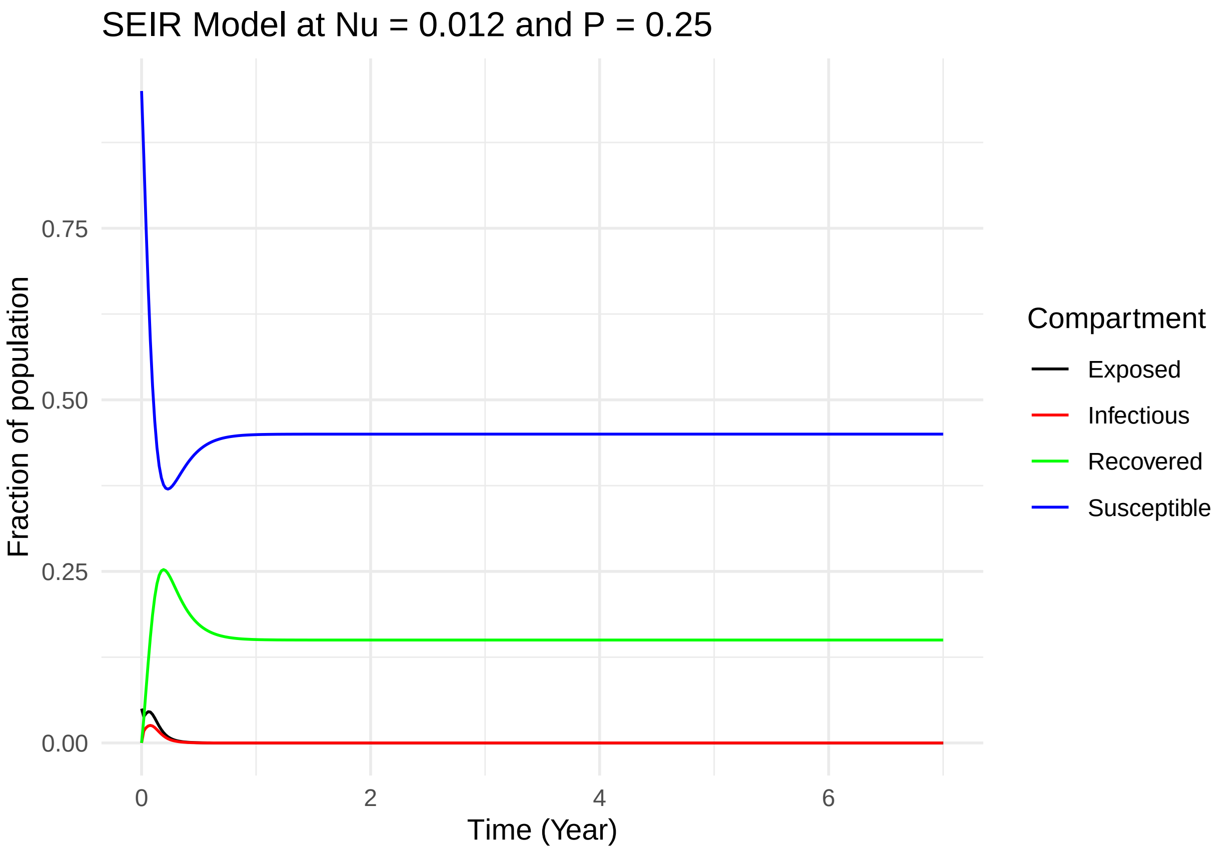
```r
plot.param(weekly.report)
```




```
run.simu <- function(parameters){
  # Solve the SEIR equations
output <- ode(y = initial_state, times = t, func = SEIR_model, parms = parameters)

# Convert output to data frame for plotting
output_df <- as.data.frame(output)
weekly.report <- output_df[seq(1, nrow(output_df), by = 7),]
plot.param(weekly.report)
}
```

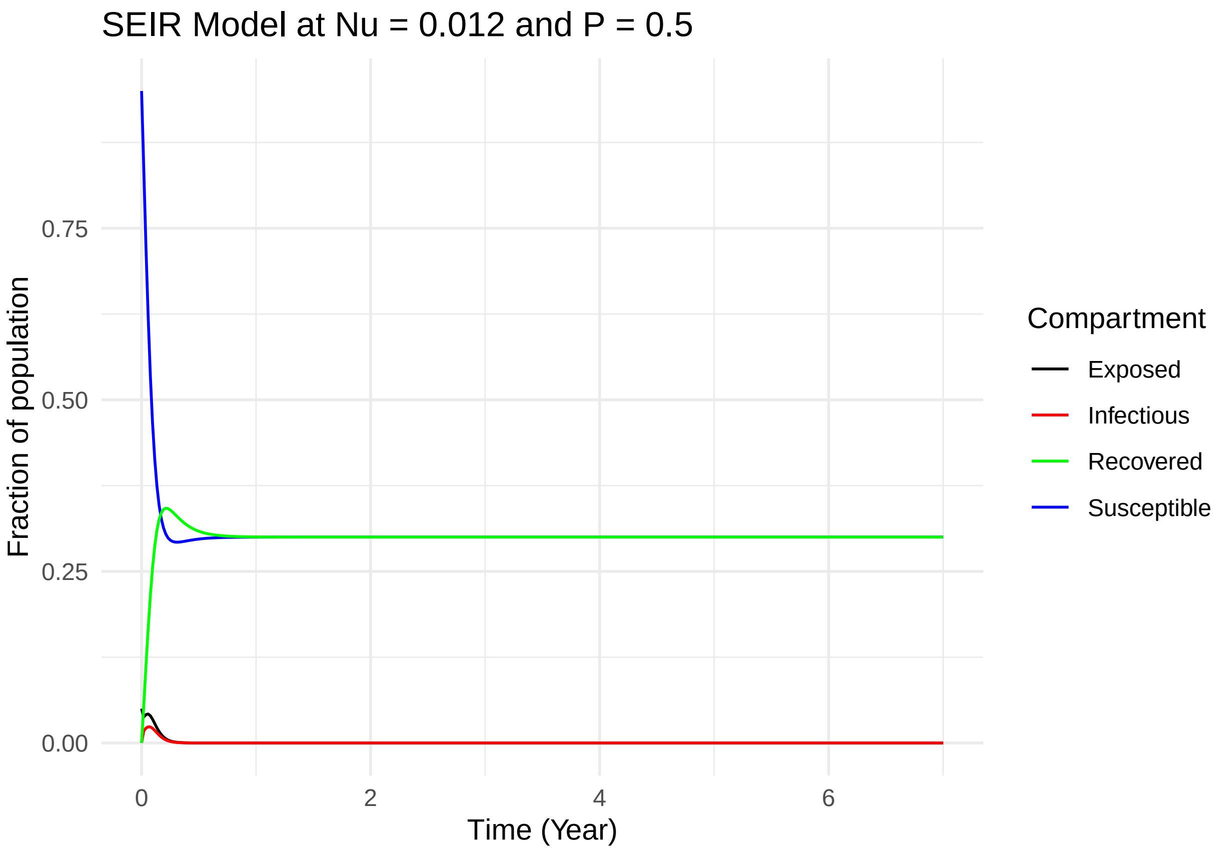
for Nu = 0.12 and 0.25

```
parameters["nu"] <- 0.012 * N0
parameters["p"] <- 0.25

run.simu(parameters = parameters)
```



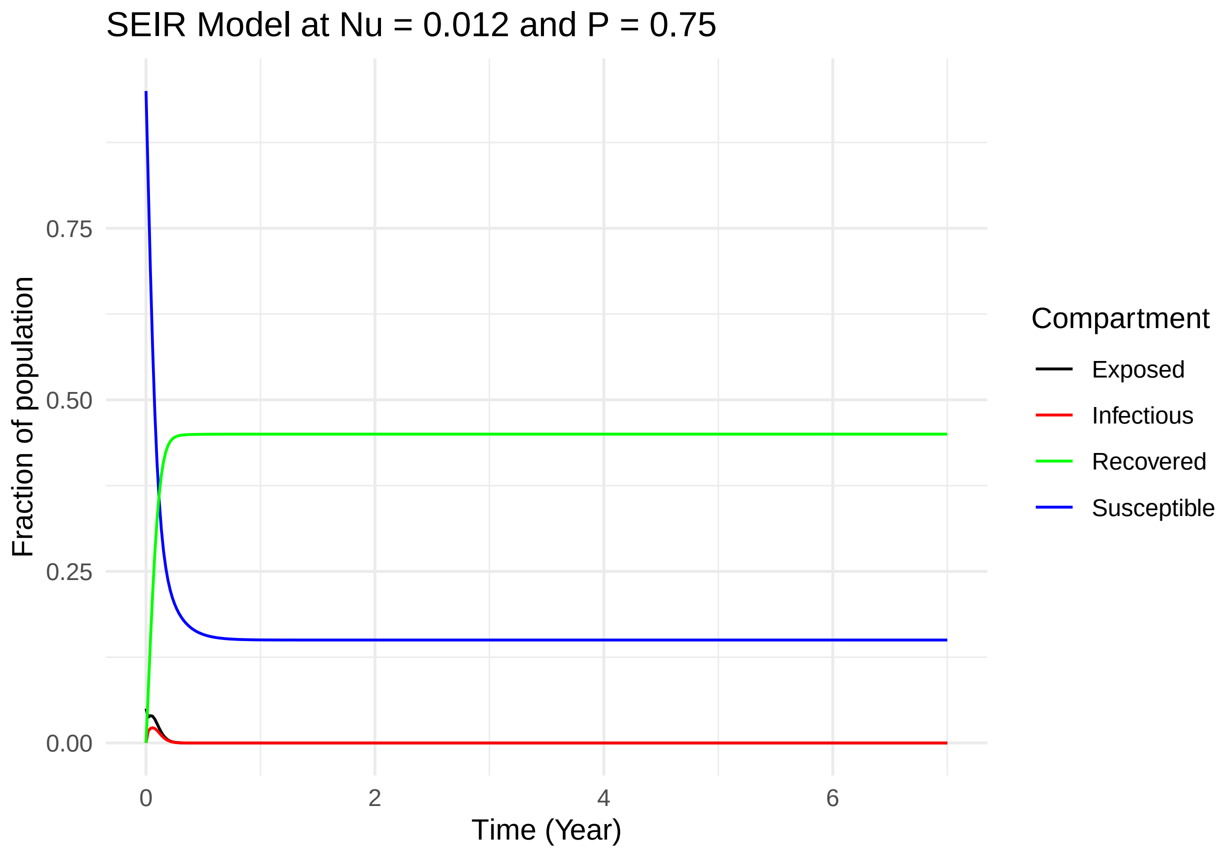
Nu = 0.012, p = 0.5

```
parameters["nu"] <- 0.012 * N0
parameters["p"] <- 0.5

run.simu(parameters = parameters)
```



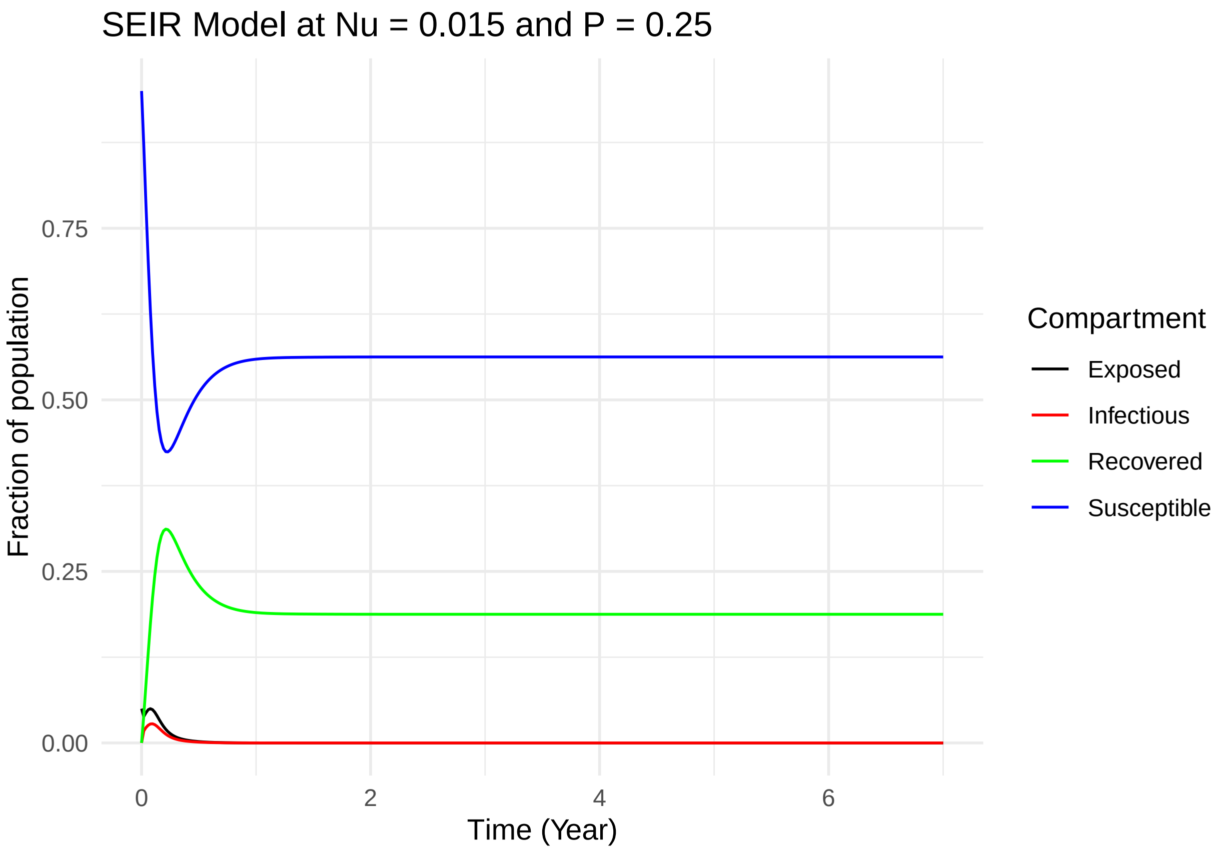
Nu = 0.012 p = 0.75

```
parameters["nu"] <- 0.012 * N0
parameters["p"] <- 0.75

run.simu(parameters = parameters)
```



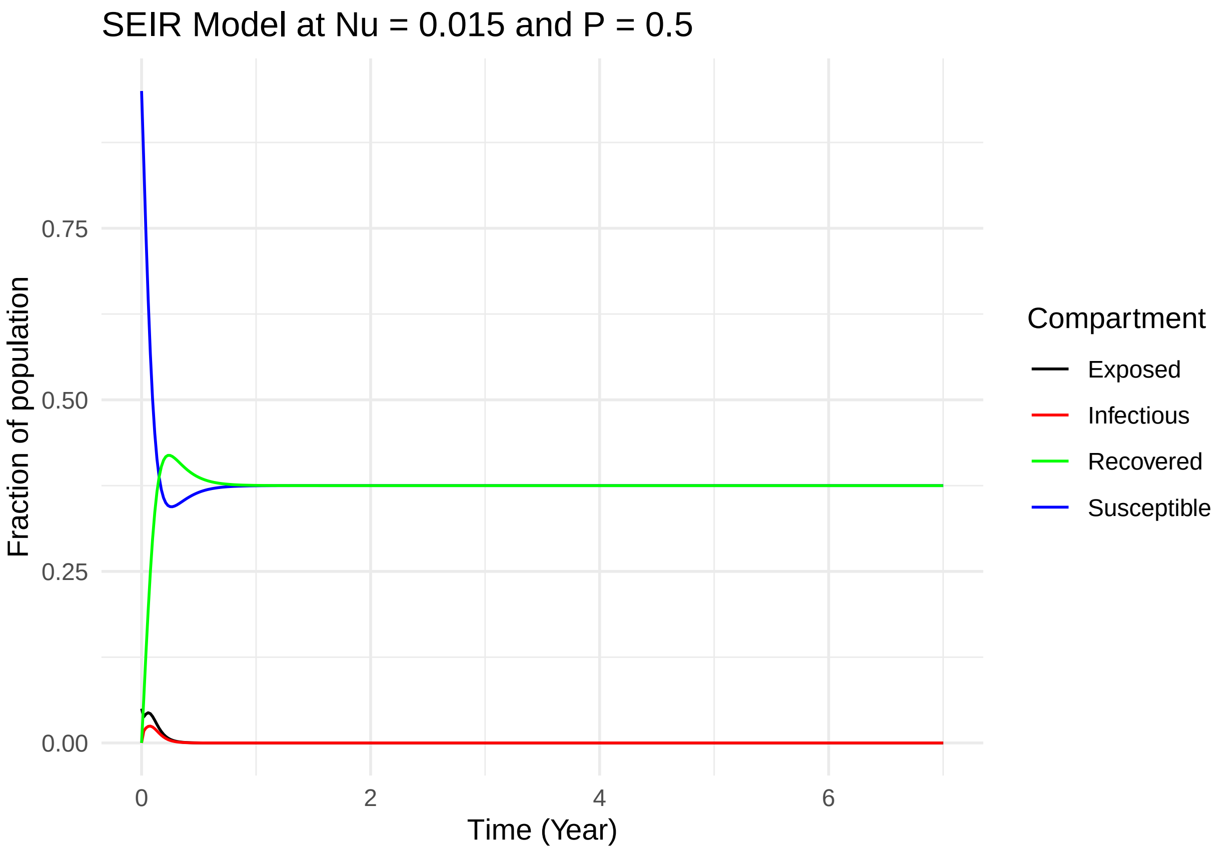
Nu = 0.015 p = 0.25

```
parameters["nu"] <- 0.015 * N0
parameters["p"] <- 0.25

run.simu(parameters = parameters)
```



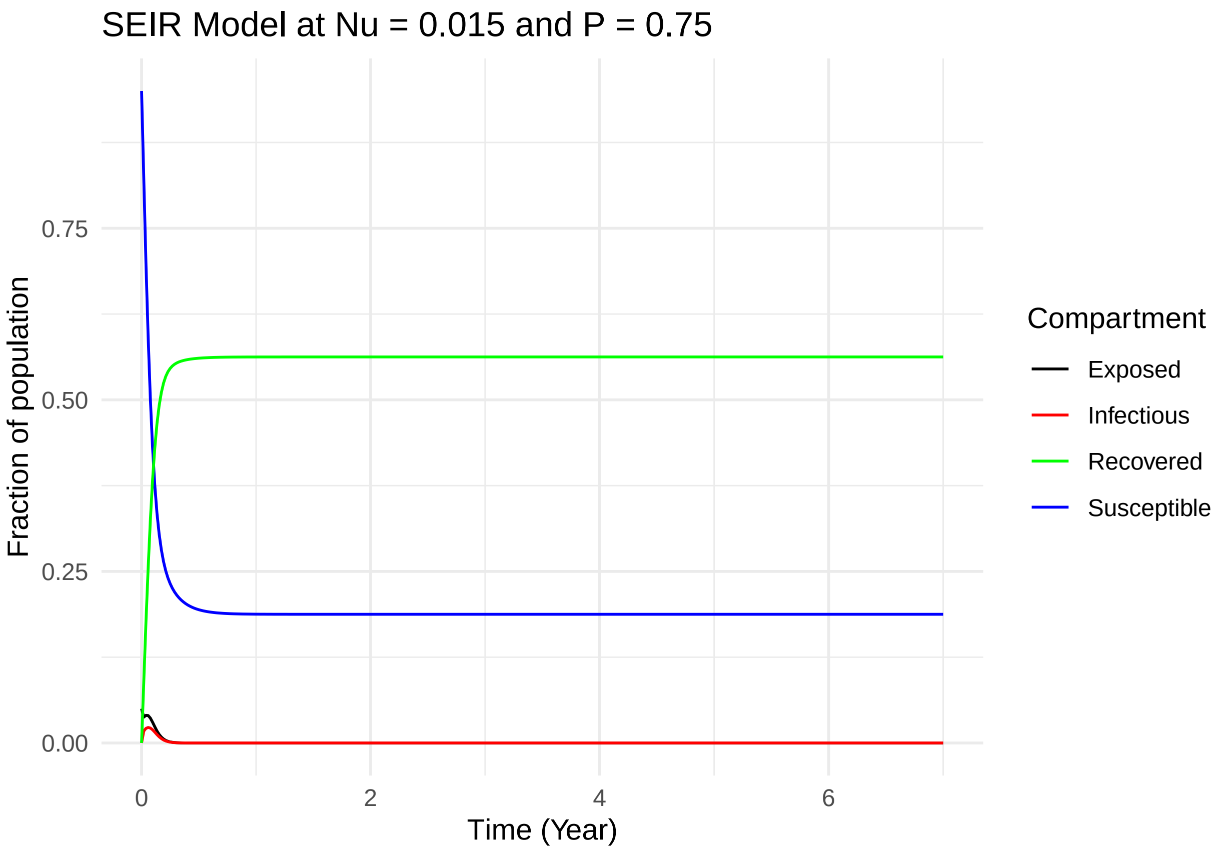
Nu = 0.015 p = 0.5

```
parameters["nu"] <- 0.015 * N0
parameters["p"] <- 0.5

run.simu(parameters = parameters)
```



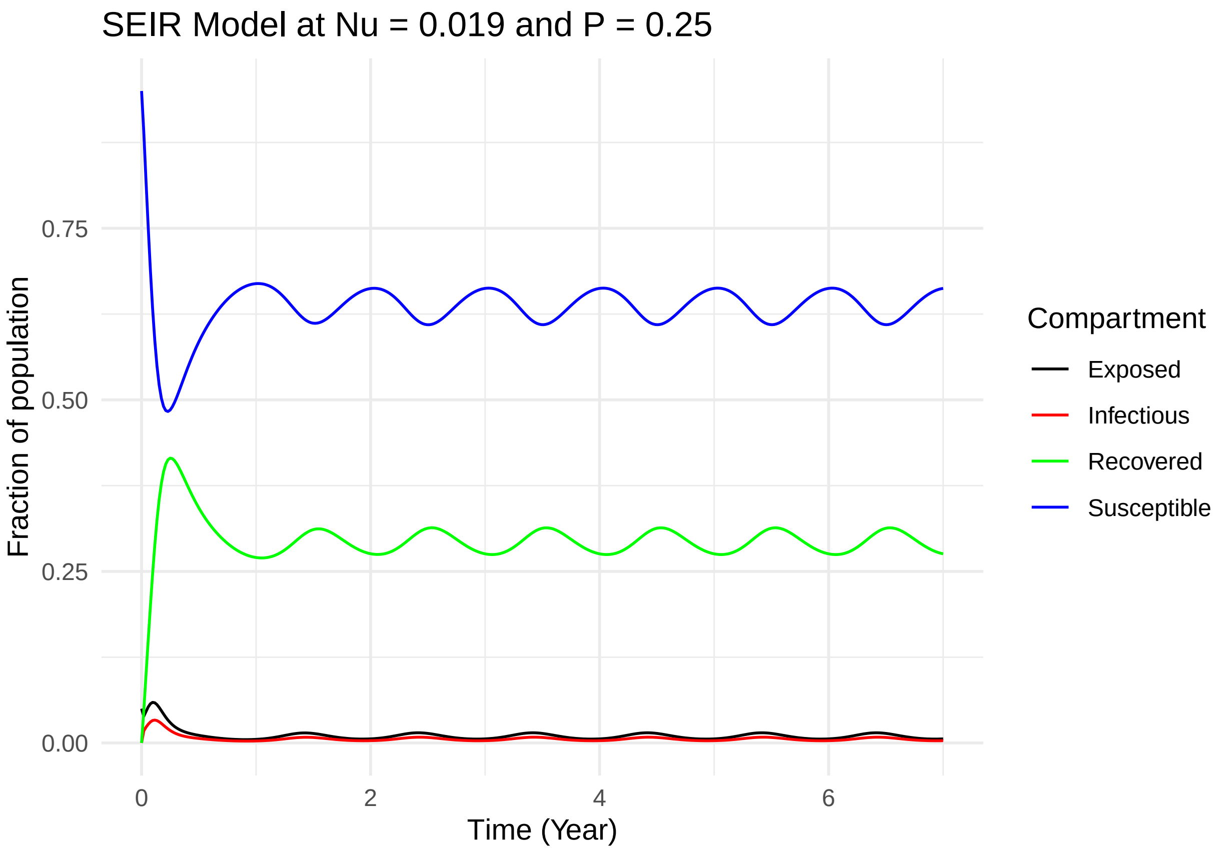
Nu = 0.015 p = 0.75

```r
parameters["nu"] <- 0.015 * N0
parameters["p"] <- 0.75

run.simu(parameters = parameters)
```



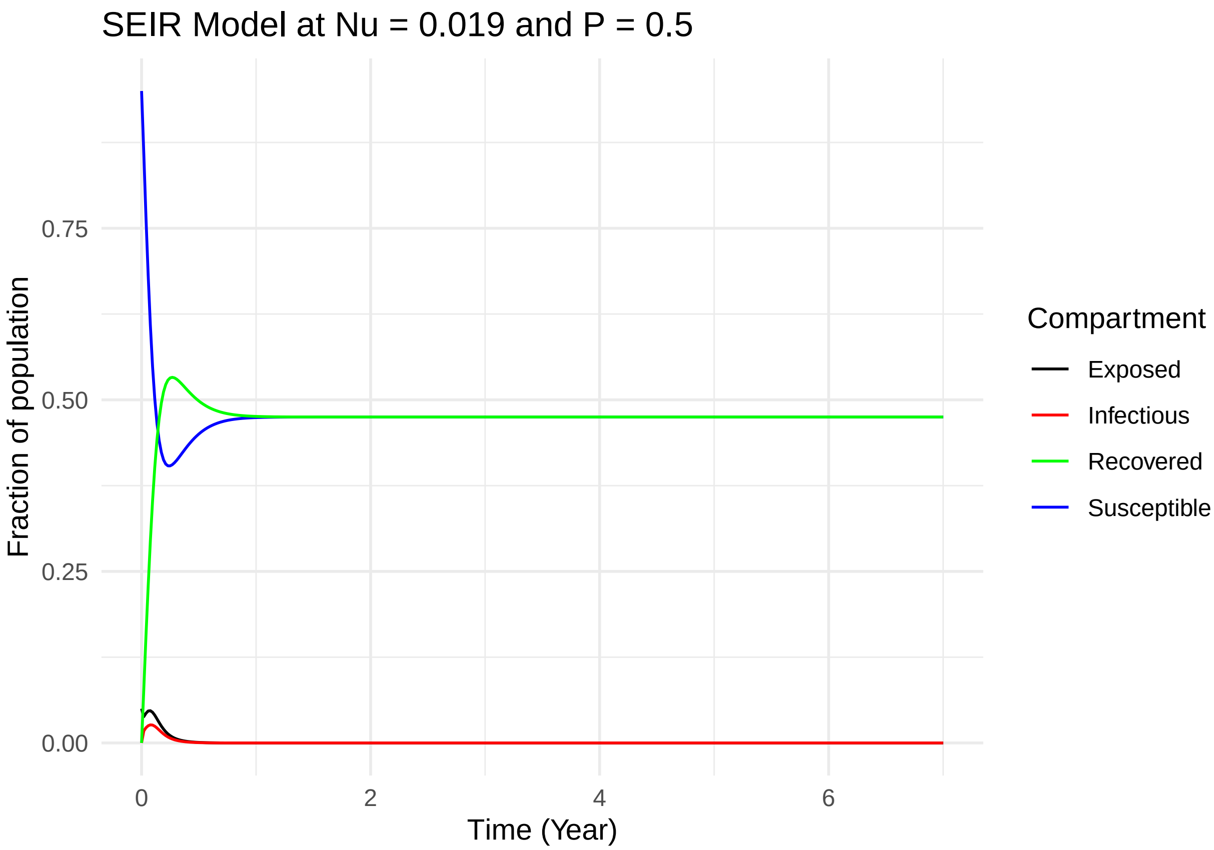
Nu = 0.019 p = 0.25

```
parameters["nu"] <- 0.019 * N0
parameters["p"] <- 0.25

run.simu(parameters = parameters)
```



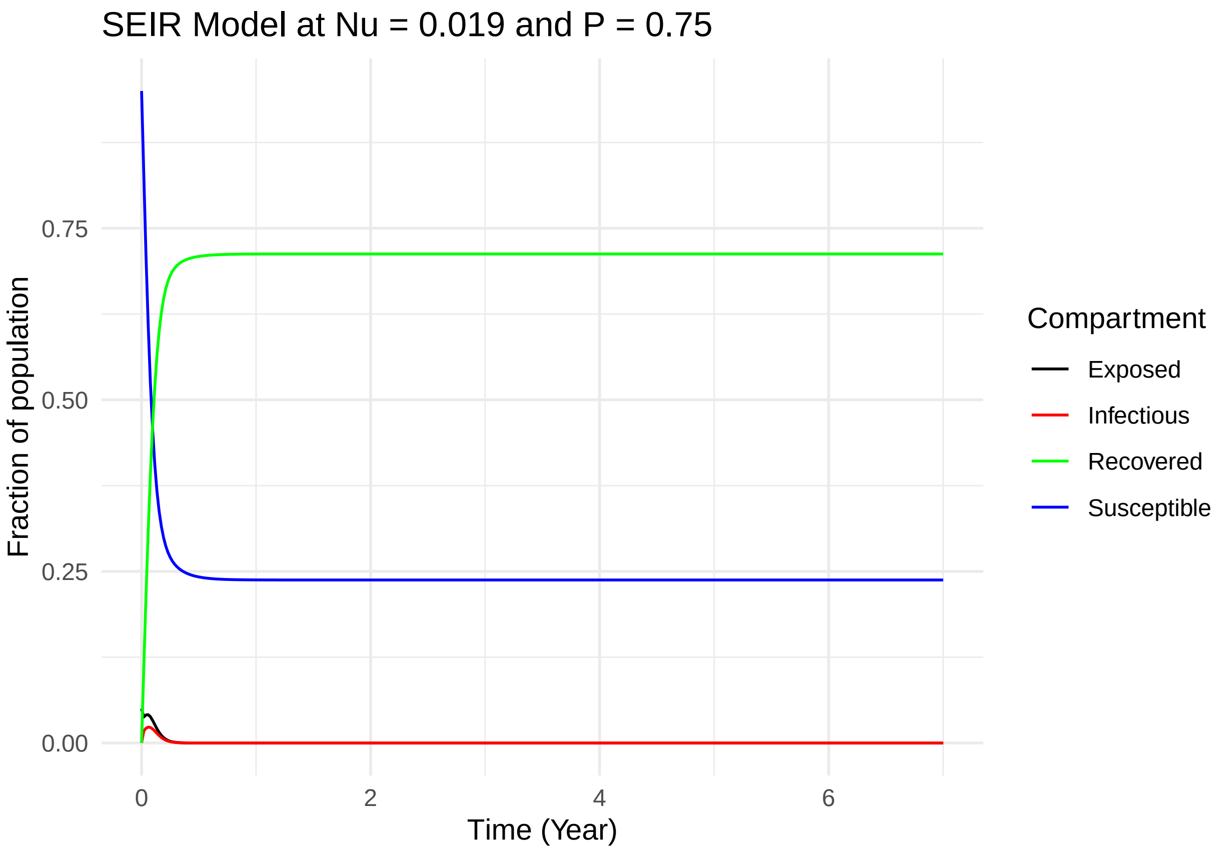
Nu = 0.019 p = 0.5

```
parameters["nu"] <- 0.019 * N0
parameters["p"] <- 0.5

run.simu(parameters = parameters)
```



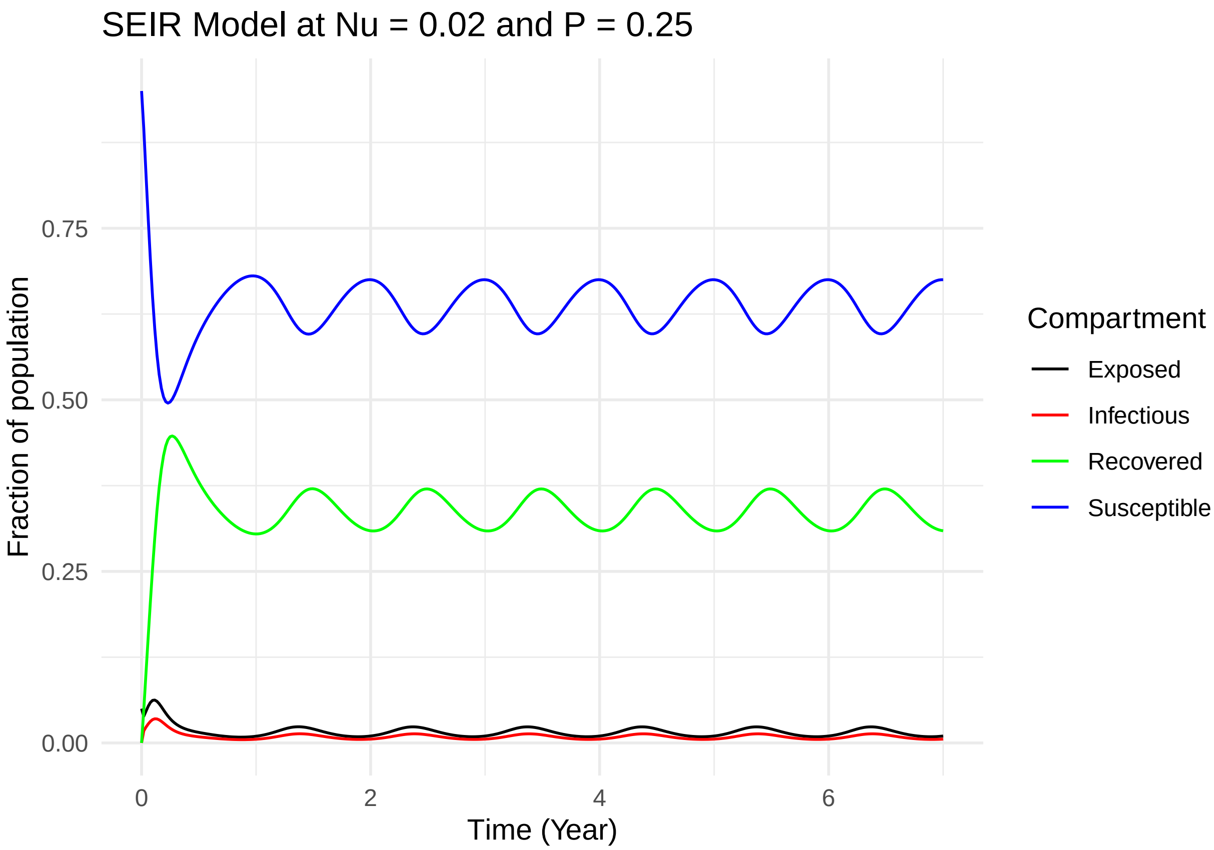
Nu = 0.019 p = 0.75

```
parameters["nu"] <- 0.019 * N0
parameters["p"] <- 0.75

run.simu(parameters = parameters)
```



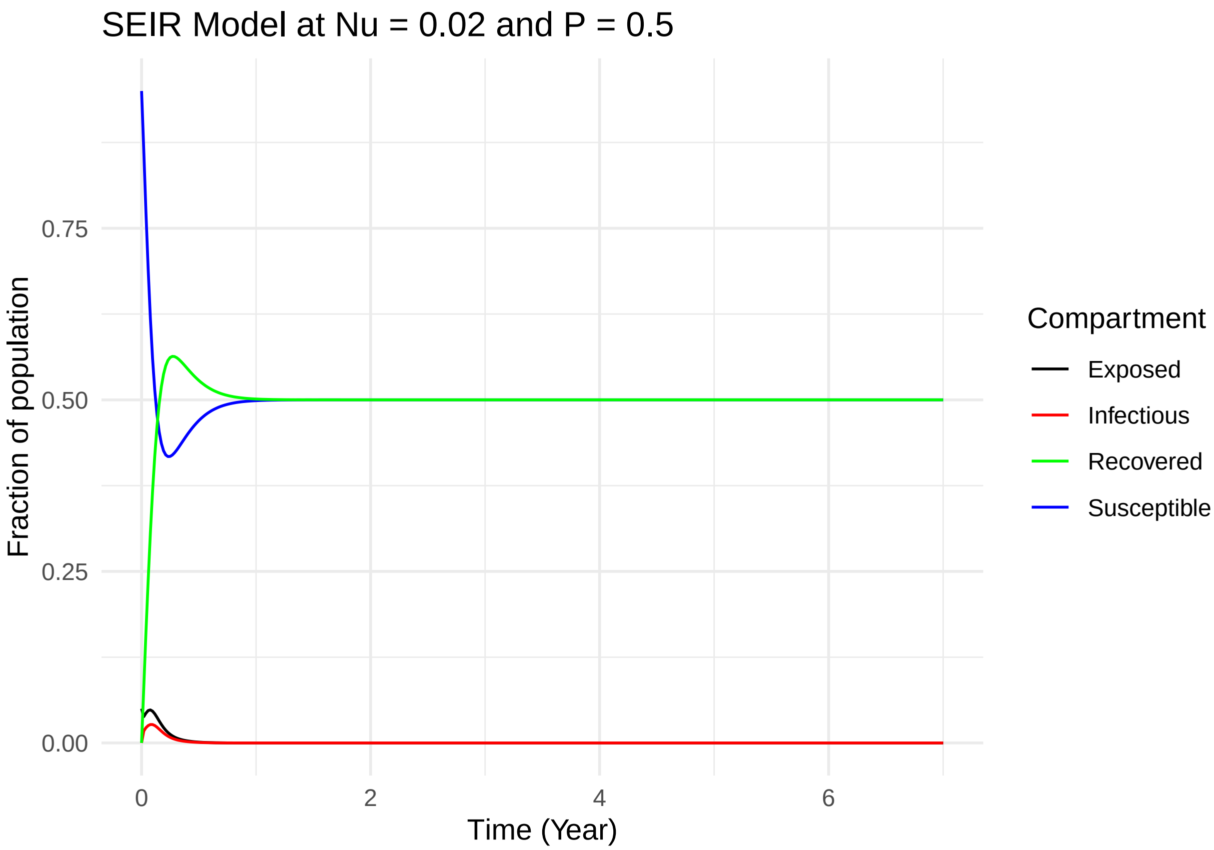
Nu = 0.02 p = 0.25

```r
parameters["nu"] <- 0.02 * N0
parameters["p"] <- 0.25

run.simu(parameters = parameters)
```



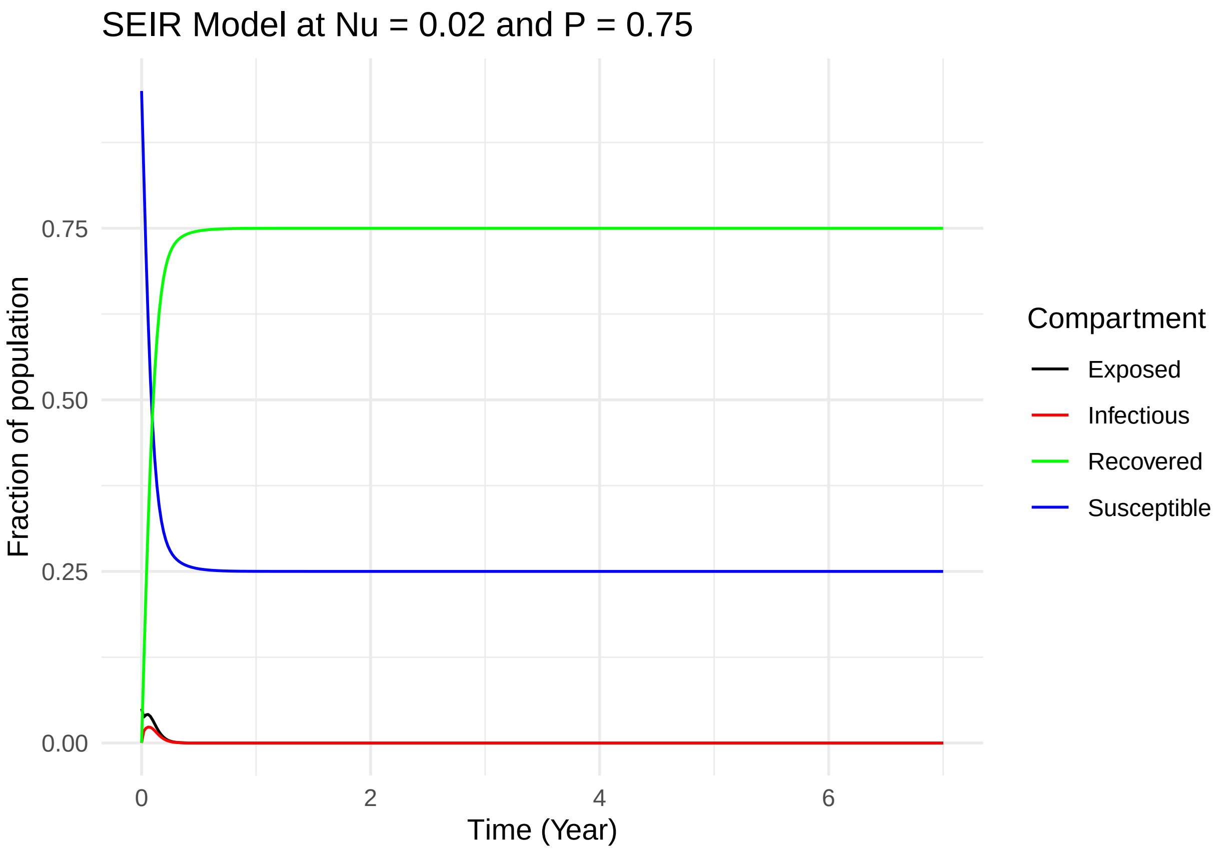
Nu = 0.02 p = 0.5

```
parameters["nu"] <- 0.02 * N0
parameters["p"] <- 0.5

run.simu(parameters = parameters)
```



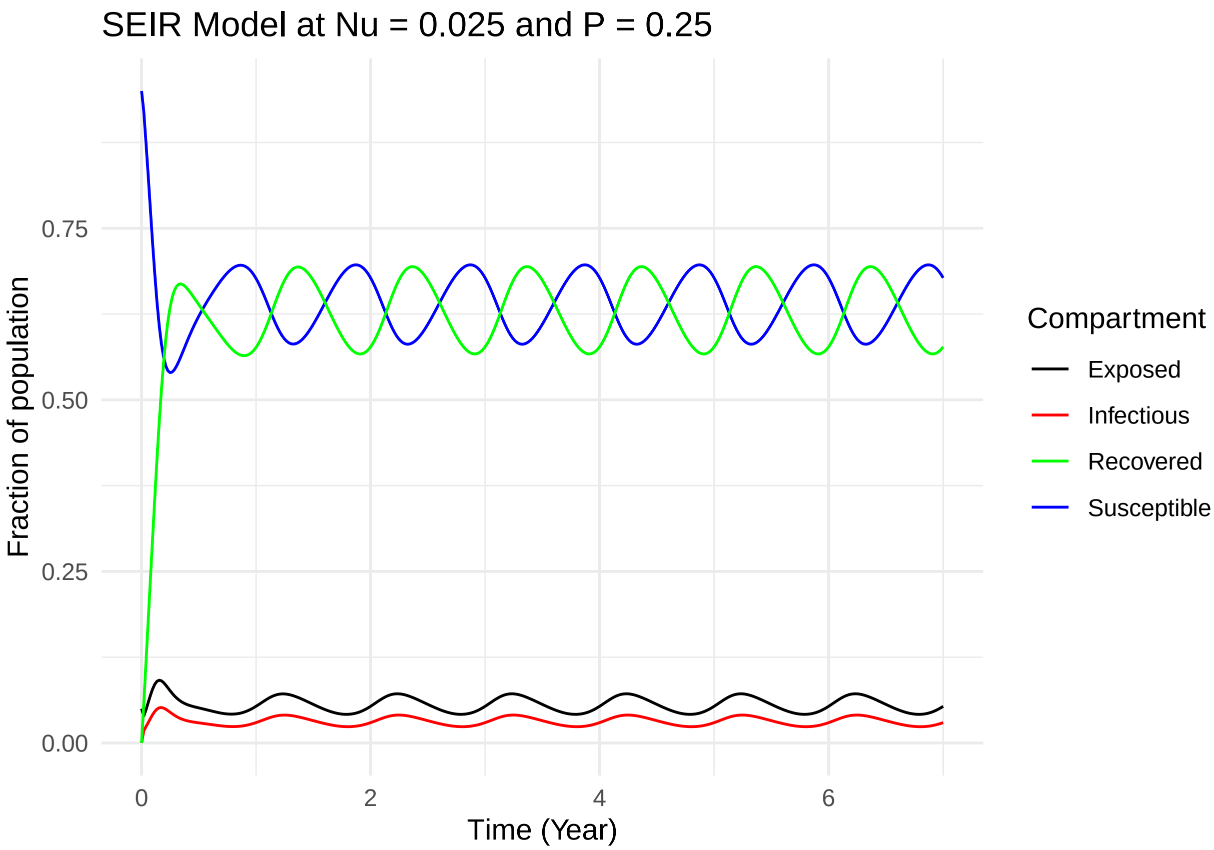
Nu = 0.02 p = 0.75

```
parameters["nu"] <- 0.02 * N0
parameters["p"] <- 0.75

run.simu(parameters = parameters)
```



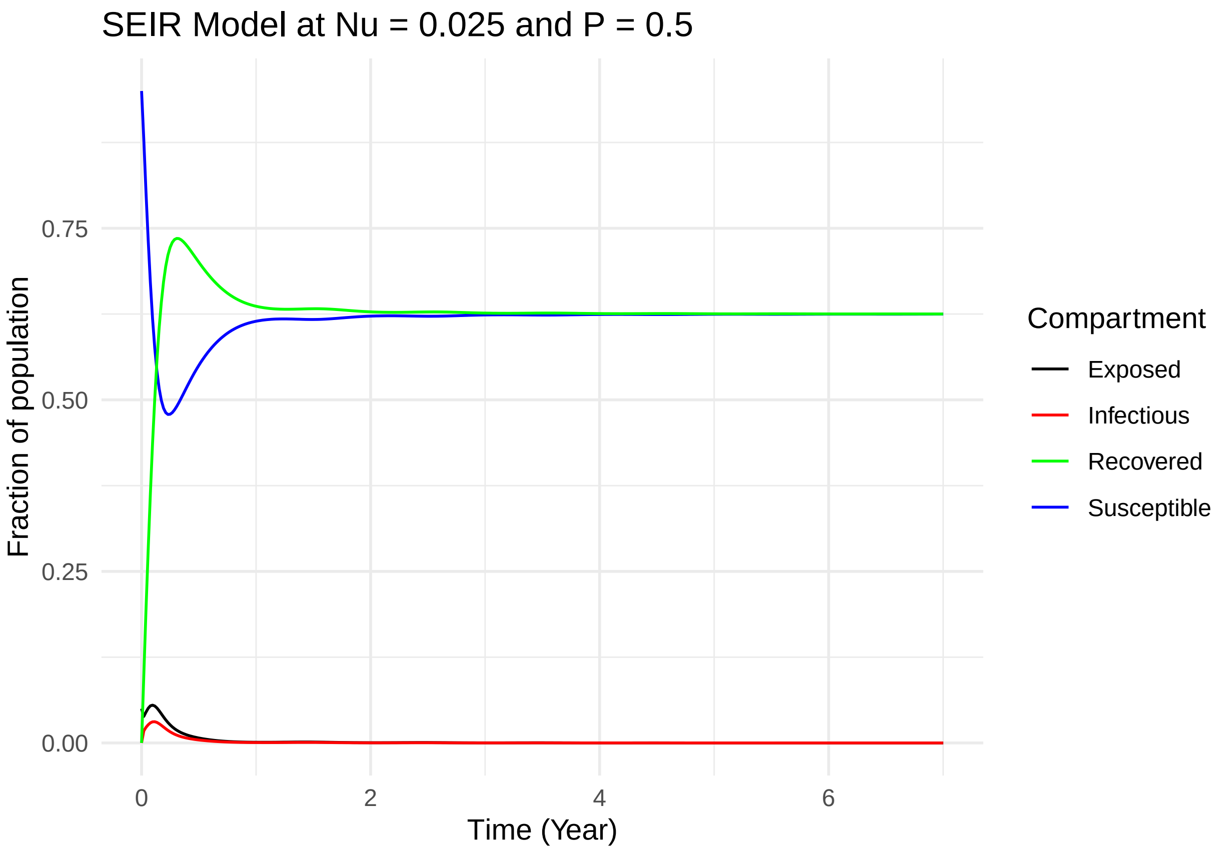
Nu = 0.025 p = 0.25

```
parameters["nu"] <- 0.025 * N0
parameters["p"] <- 0.25

run.simu(parameters = parameters)
```



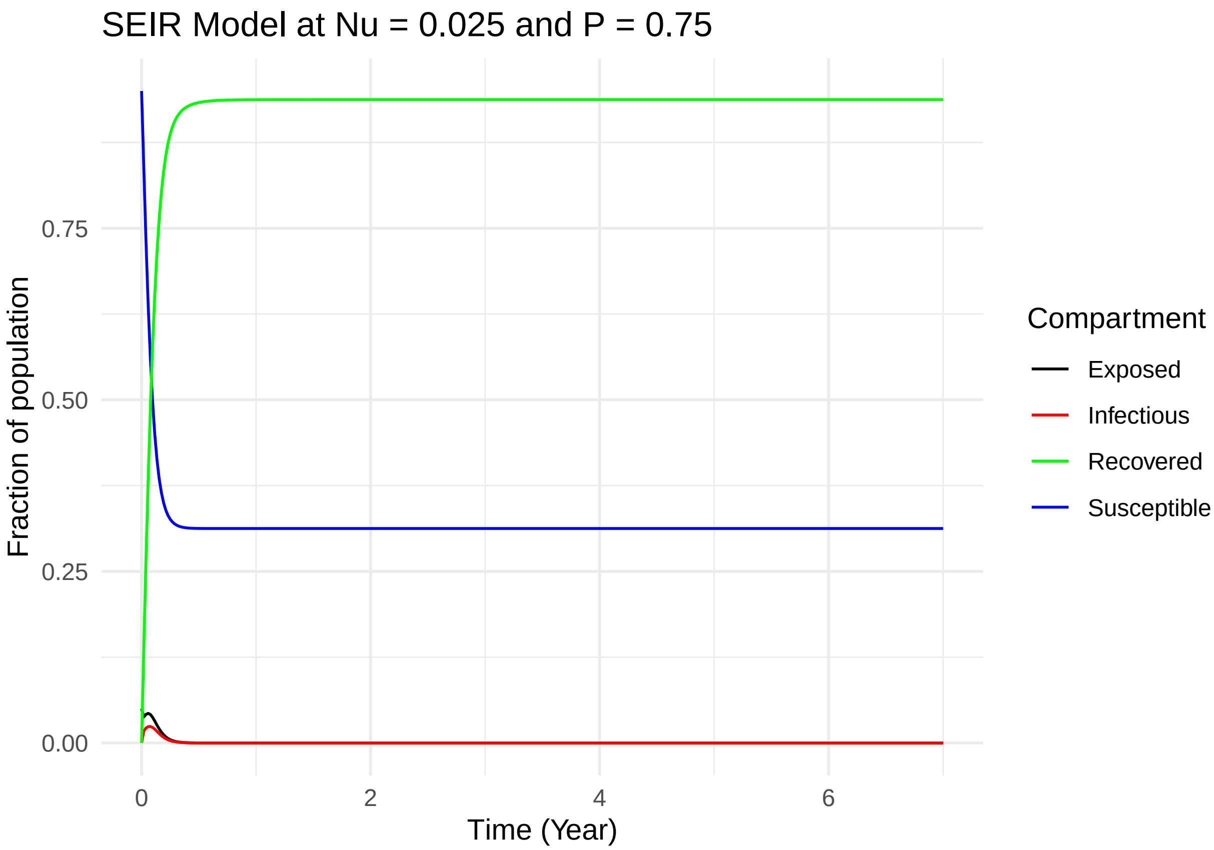
Nu = 0.025 p = 0.5

```
parameters["nu"] <- 0.025 * N0
parameters["p"] <- 0.5

run.simu(parameters = parameters)
```



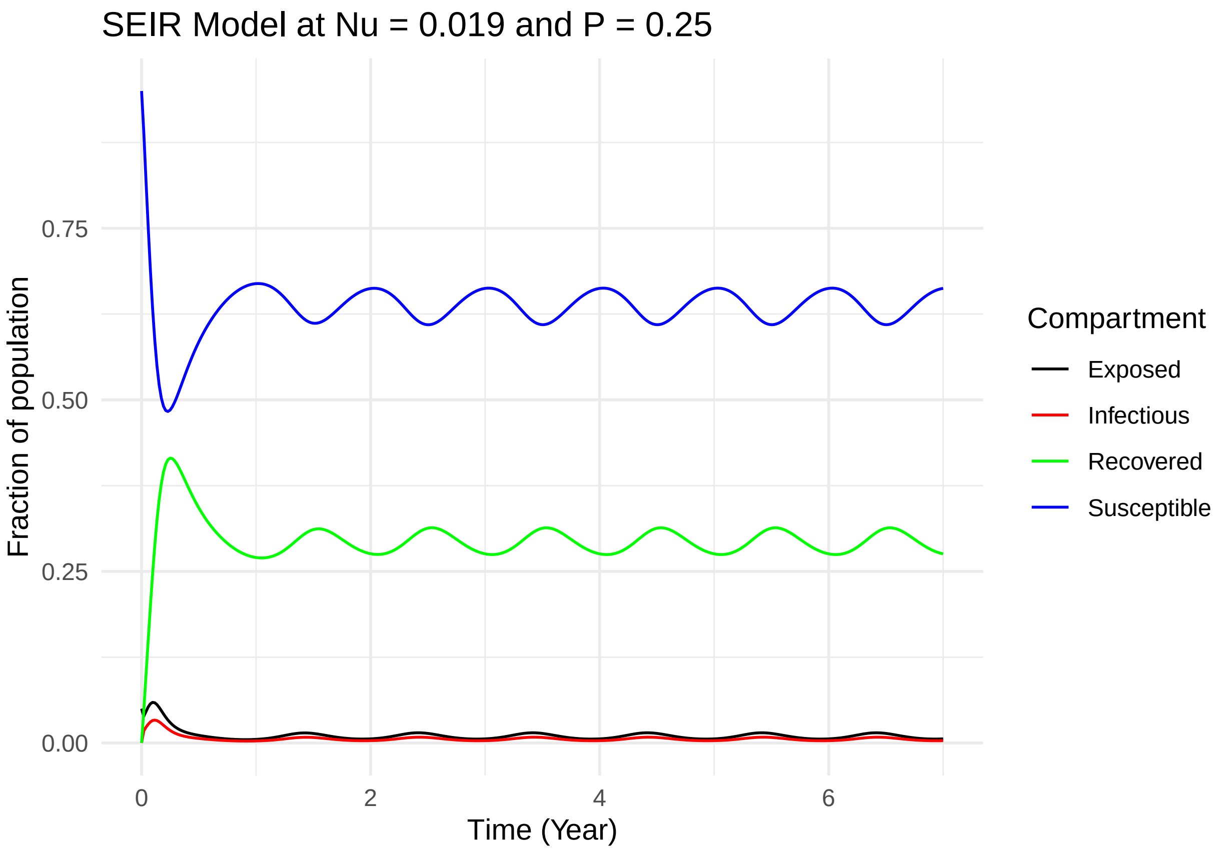
Nu = 0.025 p = 0.75

```
parameters["nu"] <- 0.025 * N0
parameters["p"] <- 0.75

run.simu(parameters = parameters)
```



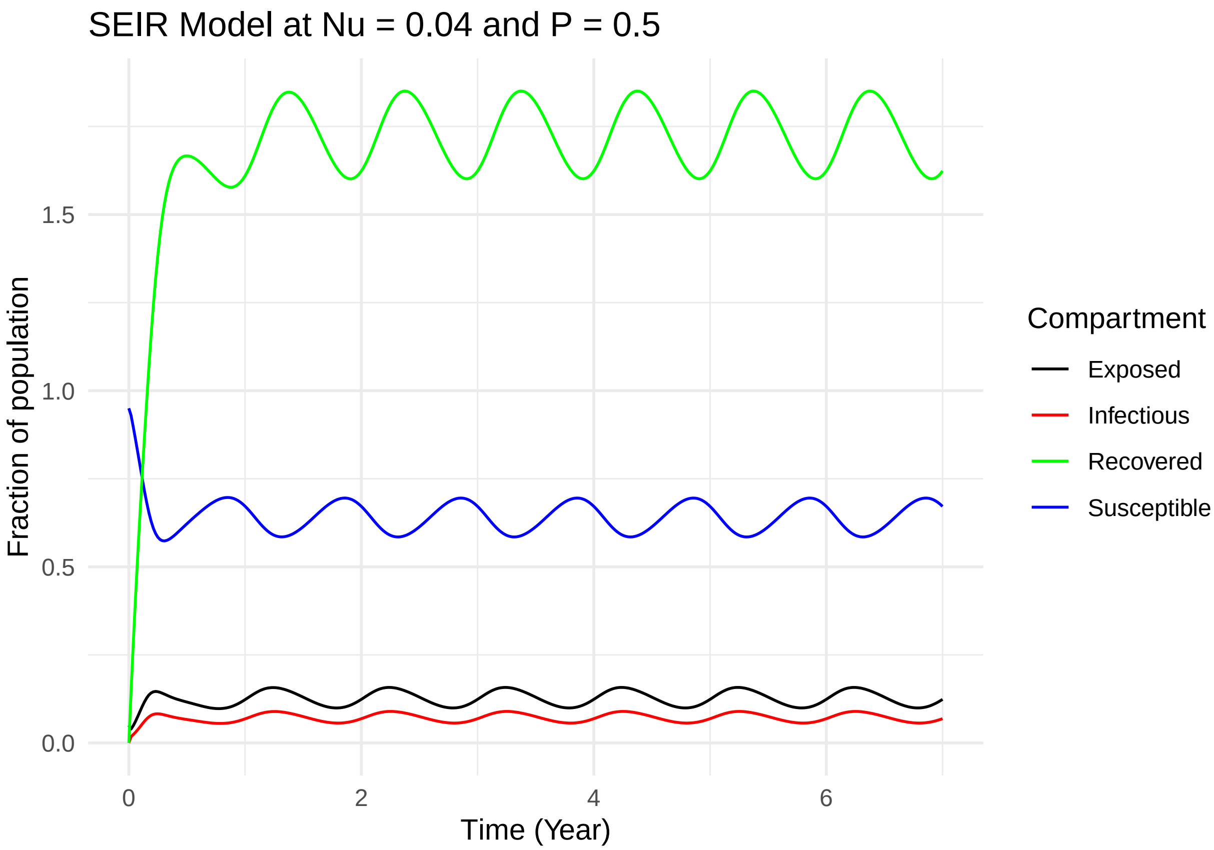
Nu = 0.03 p = 0.5

```
parameters["nu"] <- 0.019 * N0
parameters["p"] <- 0.25

run.simu(parameters = parameters)
```



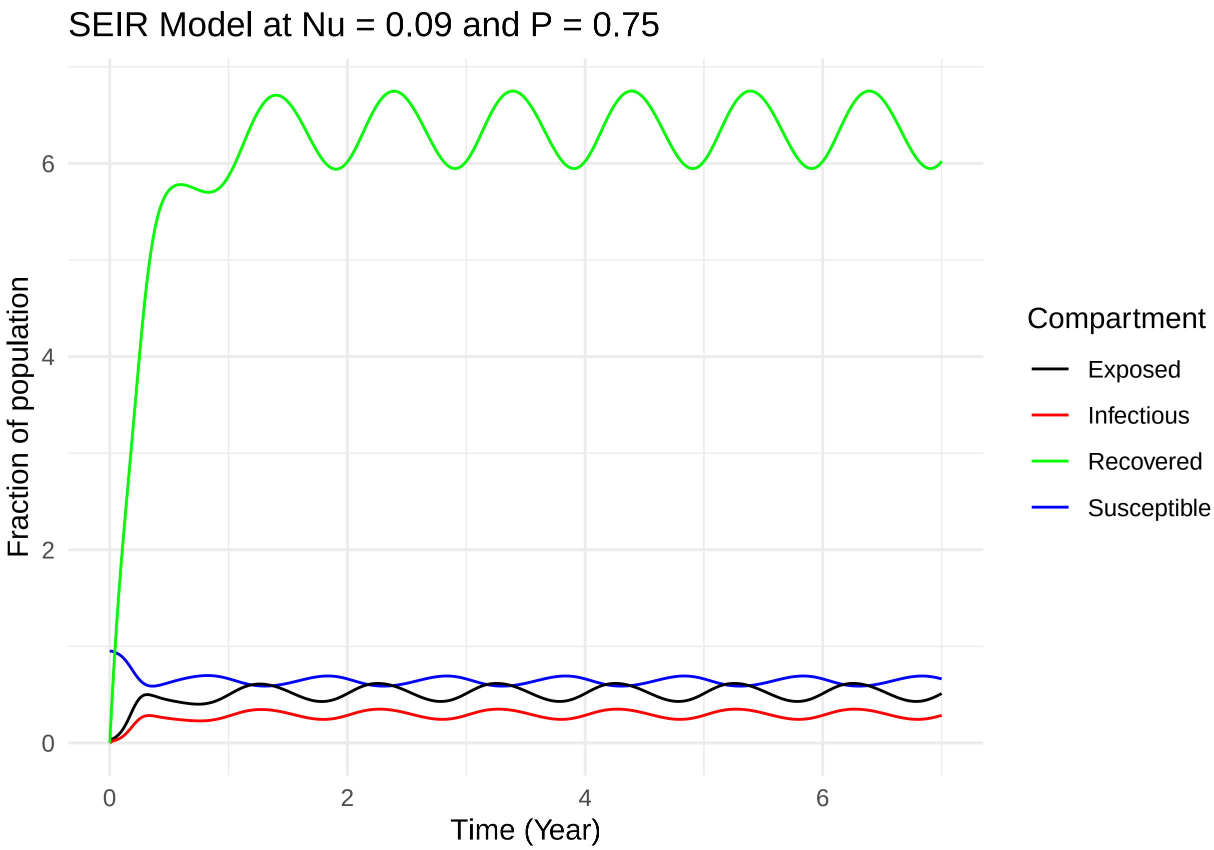
Nu = 0.05 p = 0.5

```
parameters["nu"] <- 0.04 * N0
parameters["p"] <- 0.5

run.simu(parameters = parameters)
```



Nu = 0.09 p = 0.5

```
parameters["nu"] <- 0.09 * N0
parameters["p"] <- 0.75

run.simu(parameters = parameters)
```


SEIR Model at Nu = 0.09 and P = 0.75
Fraction of population
Time (Year)
0
2
4
6
Compartment
Exposed
Infectious
Recovered
Susceptible