Homework 5

STAT 430: Infectious Diseases Modeling

04/11/2022

Parts 1-4

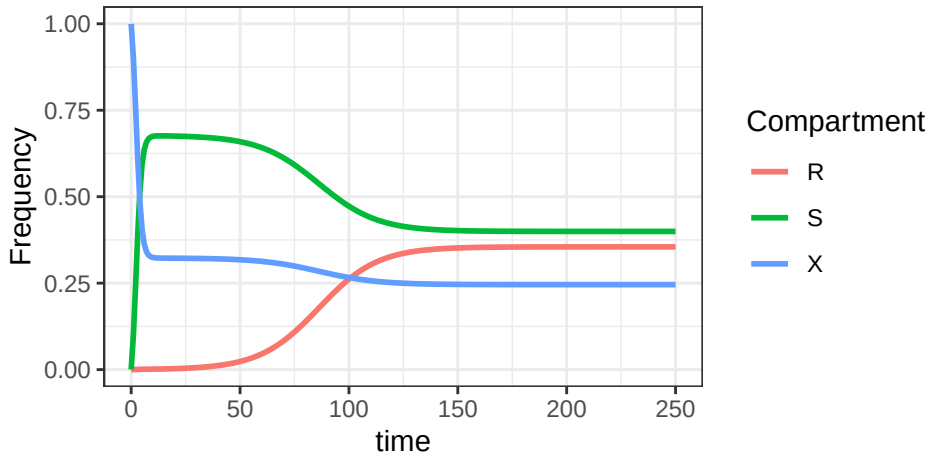
```
# Libraries
library(bbmle)
library(epimdr)
library(deSolve)
library(tidyverse)
```

SXR function:

```
sxr <- function(t, y, pars){
  # State variables
  S <- y[1]
  X <- y[2]
  R <- y[3]

  # Parameter values
  beta <- pars["beta"]
  gamma <- pars["gamma"]
  tau1 <- pars ["tau1"]
  tau2 <- pars ["tau2"]
  m <- pars ["m"]
  c <- pars ["c"]
  mu <- pars ["mu"]


  # Equations
  dS <- m*mu + beta*S*X - (tau1+tau2+gamma+mu)*S

  dX <- (1-m)*mu +(tau1+tau2+gamma)*S + (tau2+gamma)*R - beta*S*X - beta*(1-c)*R*X - mu*X

  dR <- beta*(1-c)*R*X - (mu +tau2+gamma)*R

  # Return list of gradients
  out <- c(dS, dX, dR)
  list(out)
}
```

```
times<-seq(0, 250, by = 1)
paras <- c(beta = 1, c = 0.05, mu = 1/10, gamma = 1/30, m = 0.75, tau1 = 1/5, tau2 = 1/10)
init <- c(S = 0.0001, X = 0.9998, R = 0.0001)

data_out <- ode(y=init , times = times, func = sxr, parms = paras)
data_out <- as_tibble(data_out)
```

```
data_out %>% pivot_longer(cols = S:R,
  names_to = "Compartment", values_to = "Frequency") %>%
  ggplot(aes(time,Frequency, col=Compartment)) +
  geom_line(size=1) + theme_bw()
```



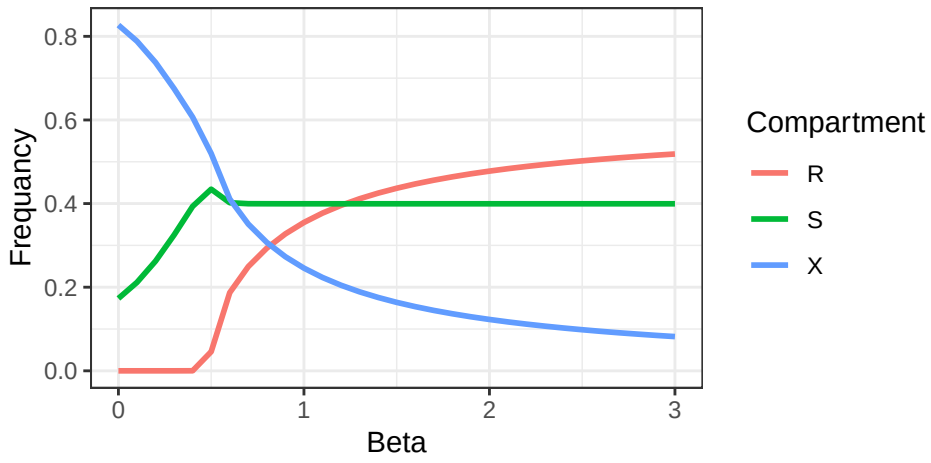
Parts 5,6, and 7

Beta

```
beta <- seq(0,3, by = 0.1)

beta.int = data.frame(NULL)

for (i in 1:length(beta))
{
  paras <- c(beta = beta[i], c = 0.05, mu = 1/10, gamma = 1/30, m = 0.75, tau1 = 1/5, tau2 = 1/10)

data.beta <- ode(y=init , times = times, func = sxr, parms = paras)
data.beta <- as_tibble(data.beta)

beta.int <- rbind(beta.int, tibble(beta = beta[i], slice_tail(data.beta, n=1)))
}
```

```
beta.a <- beta.int %>%pivot_longer(cols = S:R,
  names_to = "Compartment", values_to = "Frequancy")

betaplot <- beta.a %>%
  ggplot(aes(beta,Frequancy, col=Compartment)) +
```

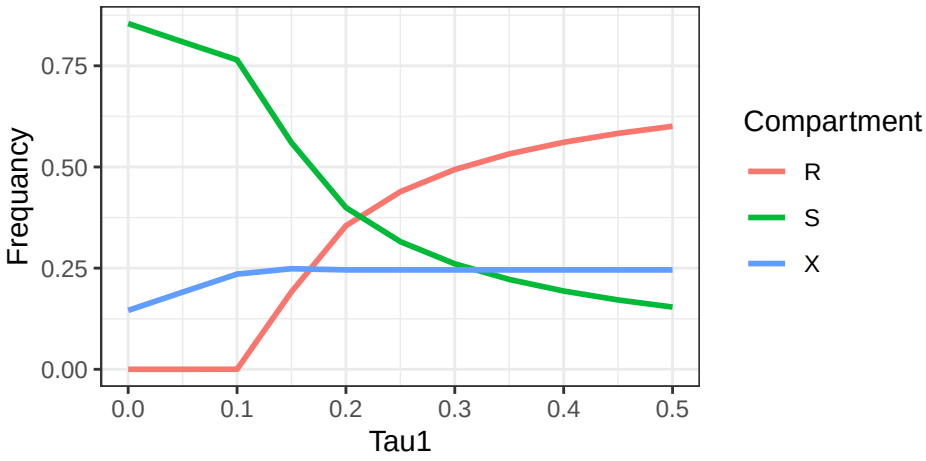
```
  geom_line(size=1) + theme_bw() + xlab("Beta")

betaplot
```



Tau1

```
tau1 <- seq(0,0.5, by = 0.05)

tau1.int = data.frame()
for (i in 1:length(tau1))
{
  paras <- c(beta = 1, c = 0.05, mu = 1/10, gamma = 1/30, m = 0.75, tau1 = tau1[i], tau2 = 1/10)

data.tau1 <- ode(y=init , times = times, func = sxr, parms = paras) %>% as_tibble()

tau1.int <- rbind(tau1.int, tibble(tau1 = tau1[i], slice_tail(data.tau1, n=1)))
}
```

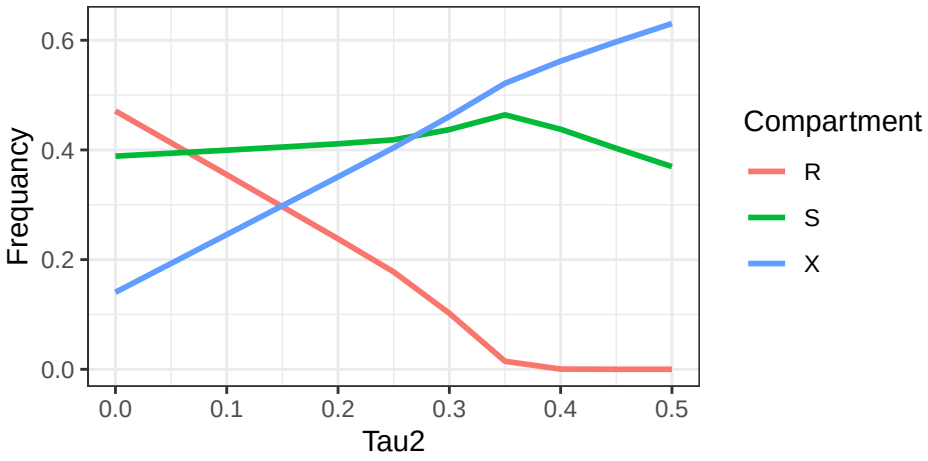
```
tau1.a <- tau1.int %>%pivot_longer(cols = S:R,
  names_to = "Compartment", values_to = "Frequancy")

tau1plot <- tau1.a %>%
  ggplot(aes(x = tau1, y= Frequancy, col=Compartment)) +
  geom_line(size=1) + theme_bw() + xlab("Tau1")

tau1plot
```



Tau2

```
tau2 <- seq(0,0.5, by = 0.05)

tau2.int = data.frame(NULL)
for (i in 1:length(tau2))
{
  paras <- c(beta = 1, c = 0.05, mu = 1/10, gamma = 1/30, m = 0.75, tau1 = 1/5, tau2 = tau2[i])

data.tau2<- ode(y=init , times = times, func = sxr, parms = paras) %>% as_tibble()

tau2.int <- rbind(tau2.int,tibble(tau2 = tau2[i], slice_tail(data.tau2, n=1)))
}
```

```
tau2.a <- tau2.int %>%pivot_longer(cols = S:R,
  names_to = "Compartment", values_to = "Frequancy")

tau2plot <- tau2.a %>%
  ggplot(aes(x = tau2, y= Frequancy, col=Compartment)) +
  geom_line(size=1) + theme_bw() + xlab("Tau2")

tau2plot
```



Part 8

As beta is increasing, the prevalence of resistance increases and then seems to start leveling out just above 0.5. Now as tau1 is increasing, resistance also increases but it looks like resistance would slightly continue to increase over time. Now tau2, resistance is decreasing and then levels out to 0.