Discussion A: more on changing parameters

Let's look at the script from our last discussion. It is an ordinary differential equation SIR model.

```
require(deSolve);require(ggplot2)
```

```
## Loading required package: deSolve
```

```
## Loading required package: ggplot2
```

```
## Warning: package 'ggplot2' was built under R version 3.5.2
```

```
S0 = 1-.0001
I0 = .0001
R0 = 0
state_vars = c(SS = S0, II = I0, RR = R0)

#Generate a  series of times for the ODE solver
tseq <- seq(0, 60, by = .1)
#Generate a vector of parameter values
pars <- c(beta = 1.4247, gamma = 0.14, mu = 0.0000391)

SIR_system <- function(tseq, state_vars, pars){
    SS = state_vars[1]
    II = state_vars[2]
```

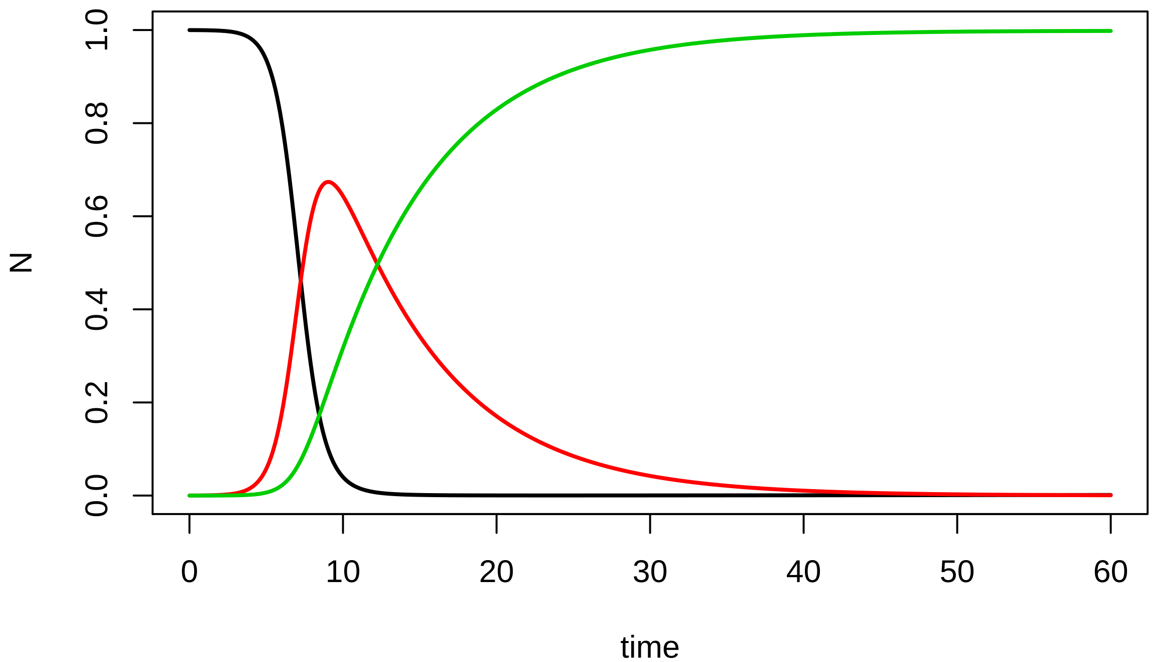
```
    RR = state_vars[3]

    beta = pars[1]
    gamma = pars[2]
    mu = pars[3]

    dS_dt = mu*(SS+II+state_vars[3]) -
        beta*SS*II - mu*SS
    dI_dt = beta*SS*II -
        gamma*II - mu*II
    dR_dt = gamma*II - mu*state_vars[3]
    list(c(dS = dS_dt, dI = dI_dt, dR = dR_dt))
}

output <- lsoda(state_vars, tseq, SIR_system, pars)

plot(output[,1],output[,2],type = "l",lwd=2,xlab="time",ylab="N")
lines(output[,1], output[,3], col=2, lwd=2)
lines(output[,1], output[,4], col=3, lwd=2)
```



Last week we introduced discrete changes by running multiple ODE solvers for different chunks in time. But you may also want to have one of your parameters depend in time. You can do that simply by changing your model function. For example, you could have

```
SIR_system <- function(tseq, state_vars, pars){
    <...>
    beta = pars[1]*tseq
    <...>
}
```

If you want your β parameter to increase linearly with time.

Exercise: Alter the code above to have a β parameter that:

a) Has 2 discrete values for seasonality, that switch every 10 t units.

b) Decreases linearly from 3 to 1 as the epidemic continues.

c) Has continuous fluctuation between 1.4 and 1 (consider using a sine function).

d) Is some sort of sigmoidal function.

Hint: start by finding and plotting functions that do the things above, then modify the original script.