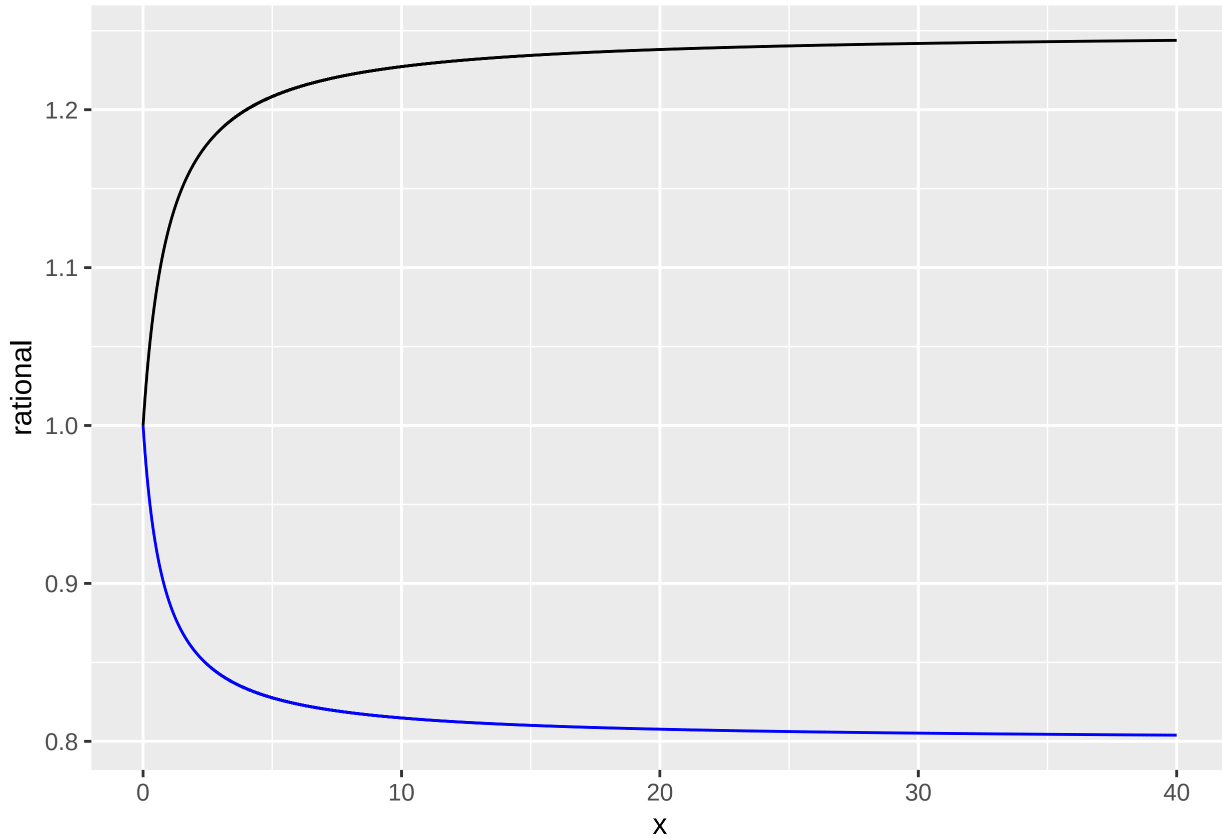
Lab 1

2023-01-17

Q1 Functions

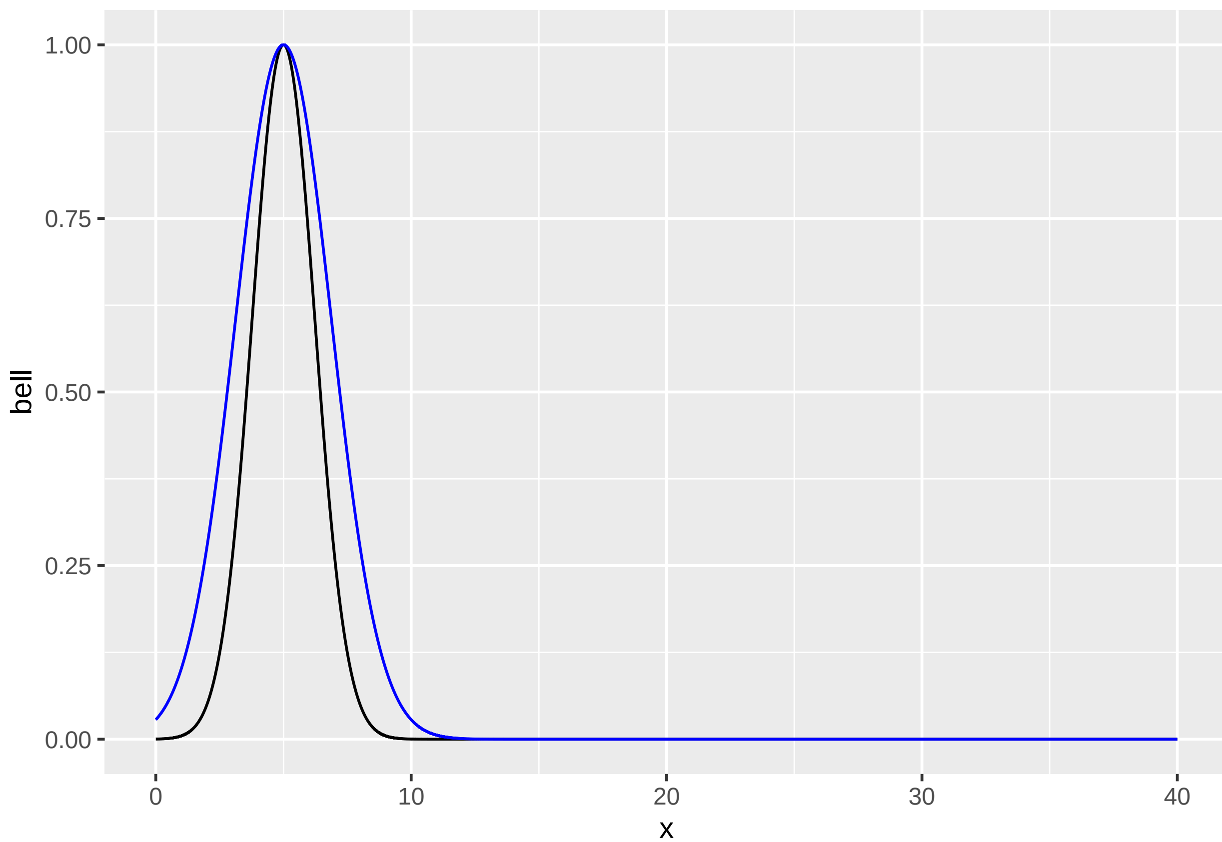
rational function 1.5

```r
a <- 1.25
b <- 1
c <- 1
d <- 1
x <- c(seq(0,40,0.001))
rational <- (a*x+c)/(b*x+d)

a2 <- 1
b2 <- 1.25
rational2 <- (a2*x+c)/(b2*x+d)
rational_plot <- as.data.frame(cbind(x, rational, rational2))

ggplot(rational_plot, aes(x)) +
  geom_line(aes(y = rational)) +
  geom_line(aes(y = rational2), colour = "blue")
```



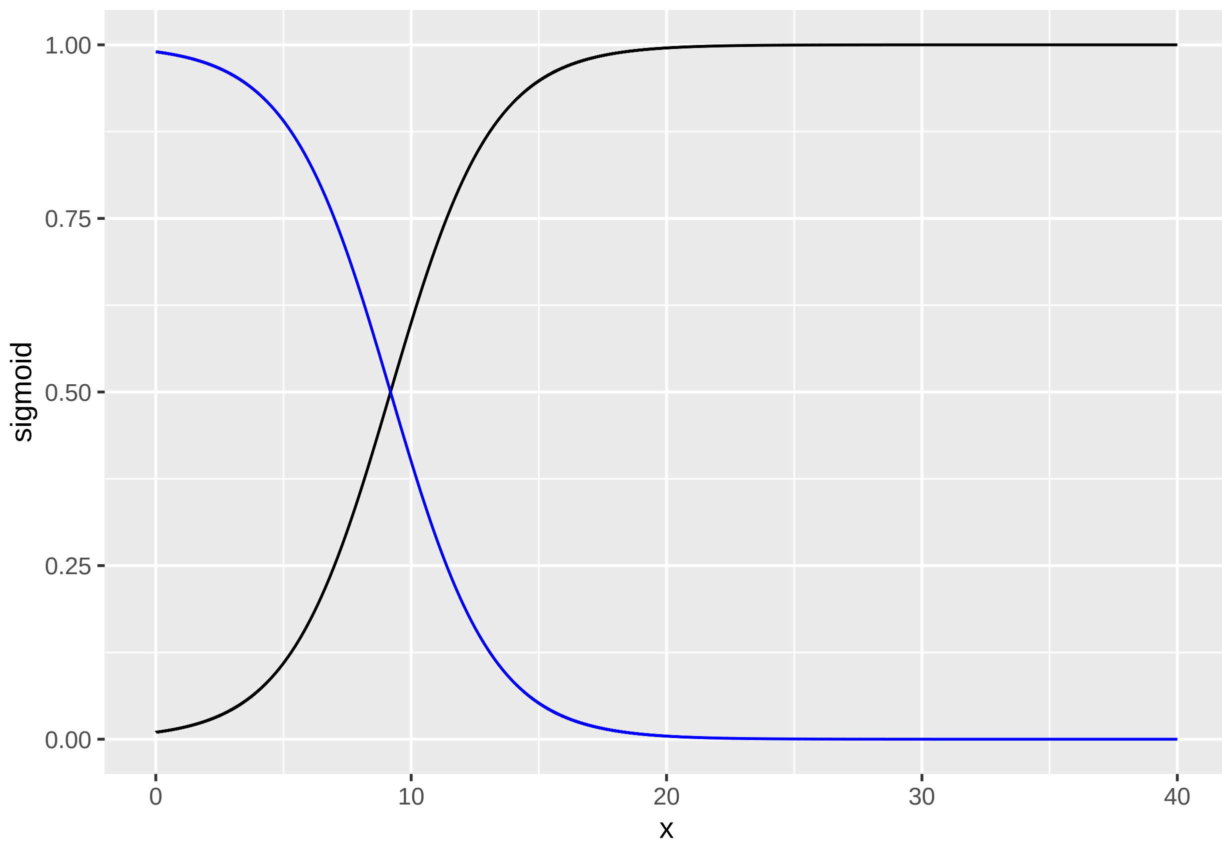
bell-shaped function 1.6

```
e <- 3
f <- 5
bell <- exp((-(x-f)^2)/e)

e2 <- 7
bell2 <- exp((-(x-f)^2)/e2)
bell_plot <- as.data.frame(cbind(x, bell, bell2))

ggplot(bell_plot, aes(x)) +
  geom_line(aes(y = bell)) +
  geom_line(aes(y = bell2), colour = "blue")
```



sigmoidal 1.7

```
g <- 0.5
h <- 0.01

sigmoid <- (h*exp(g*x))/((h*exp(g*x))+(1-h))


g2 <- -0.5
h2 <- 0.99
sigmoid2 <- (h2*exp(g2*x))/((h2*exp(g2*x))+(1-h2))
sigmoid_plot <- as.data.frame(cbind(x, sigmoid, sigmoid2))

ggplot(sigmoid_plot, aes(x)) +
  geom_line(aes(y = sigmoid)) +
  geom_line(aes(y = sigmoid2), colour = "blue")
```


1.00
0.75
0.50
0.25
0.00
sigmoid
0
10
20
30
40
x

Q2

Q2:

A1: how does # juvenile and adult mice in a population change over time?

variables: J : # juvenile mice in a population ($J \geq 0$)

A : # adult mice in a population ($A \geq 0$)

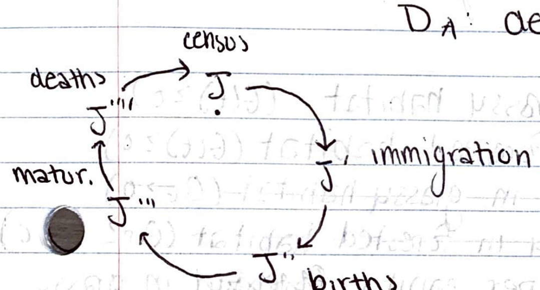
parameters: ~~M~~ I: immigration as # of J mice ($M \geq 0$) per year

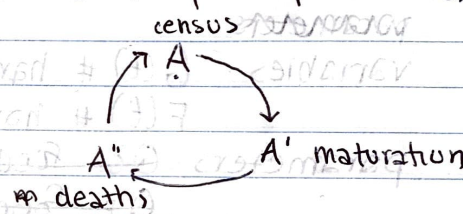
B : births per capita A ($B \geq 0$) per year

~~M~~ M: maturation as per capita J ($M \geq 0$) per yr

D_J deaths of juveniles per capita J ($D_J \geq 0$) per yr

D_A: deaths of adults per capita A ($D_A \geq 0$) per yr





$J' = J(t) + I$

$J'' = J' + B \cdot A(t)$ — original Adult pop b/c maturation hasn't occured

$J''' = J'' - M J''$

$J'''' = J''' - D_J \cdot J'''$

substitute:

$J'' = J(t) + I + B \cdot A(t)$

$J''' = J(t) + I + B \cdot A(t) - M \cdot (J(t) + I + B \cdot A(t))$

$= (J(t) + I + B \cdot A(t)) \cdot (1 - M)$

$J'''' = (J(t) + I + B \cdot A(t)) \cdot (1 - M) - D_J \cdot (J(t) + I + B \cdot A(t)) \cdot (1-M)$

$J(t+1) = (J(t) + I + B \cdot A(t)) \cdot (1-M) \cdot (1 - D_J)$

pop of juveniles after immigration and births

$A' = A(t) + M \cdot J''$

$A'' = A' - D_A \cdot A'$

substitute

$A' = A(t) + M \cdot (J(t) + I + B \cdot A(t))$

$A'' = A(t) + M \cdot (J(t) + I + B \cdot A(t)) - D_A\,(A(t) + M \cdot (J(t) + I + B \cdot A(t)))$

$A(t+1) = (A(t) + M \cdot (J(t) + I + B \cdot A(t)) \cdot (1 - D_A))$

A.2: how does the number of snowshoe hare found in one of two habitats types change over time?

~~parameters~~:

variables: $G(t)$ # hares in grassy habitat $(G(t) \geq 0)$

$F(t)$ # hares in forested habitat $(G(t) \geq 0)$

parameters: ~~Q_G: food quality in grassy habitat ($Q_G \geq 0$)~~

~~Q_F: food quality in forested habitat ($Q_F \geq$~~ 0)

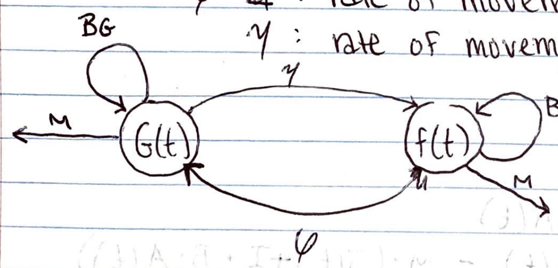
B_G: birth rate per capita ~~forested~~ in grassy

B_F: birth rate per capita in forested $(B \geq 0)$

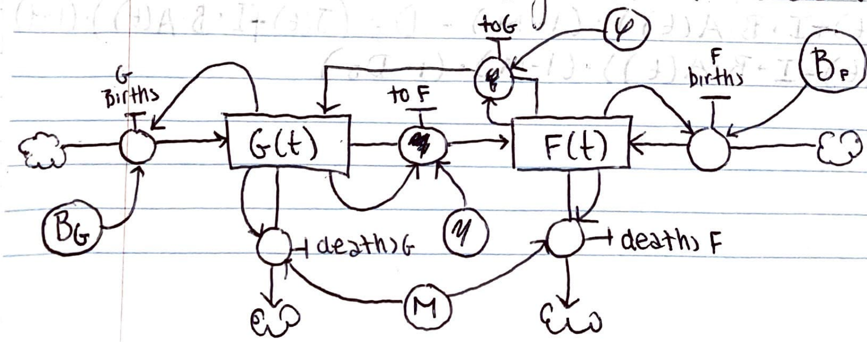
M: mortality rate per capita $(M \geq 0)$

ψ ~~I_4~~: rate of movement to grassy per capita $(\psi \geq 0)$

γ: rate of movement to forested per capita $(\gamma \geq 0)$



* I learned different diagrams: squares are variables, circles are parameters, are flows, out of system



$$\frac{dG(t)}{dt} = \text{increases} - \text{losses}$$

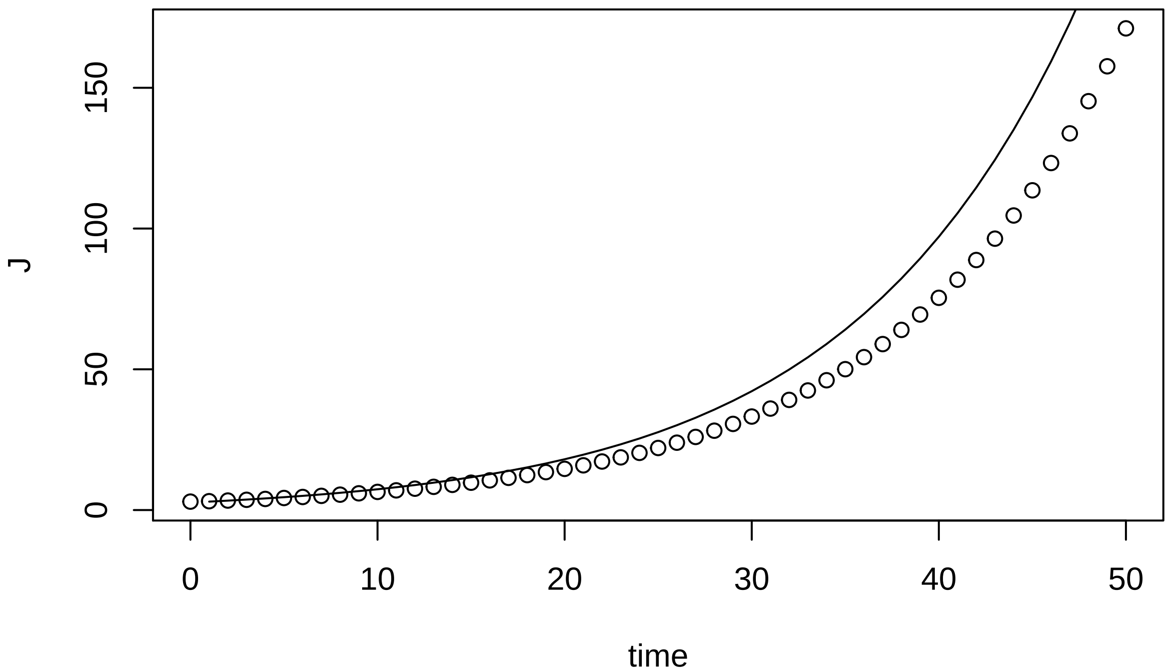
$$= B_G \cdot G(t) + \emptyset \cdot F(t) - \left(M \cdot G(t) + \gamma \cdot G(t)\right)$$

$$\frac{dF(t)}{dt} = \text{increases} - \text{losses}$$

$$= B_F \cdot F(t) + \gamma \cdot F(t) - \left(M \cdot F(t) + \emptyset \cdot F(t)\right)$$

Q3. Numerically solve

```
# parameters
I <- 1
B <- 1
M <- 0.1
DJ <- 0.5
DA <- 0.5

#variables
time <- seq(0, 50, 1)
J <- rep(0,length(time))
A <- rep(0,length(time))

# initial conditions
J[1] <- 3
A[1] <- 3

# solve
for(t in seq(1,length(time)-1,1)) {
  J[t+1]=(J[t]+I+B*A[t])*(1-M)*(1-DJ)
  A[t+1]=(A[t]+M*(J[t]+I+B*A[t])*(1-DA))
}

plot(time, J) +
  lines(A)
```



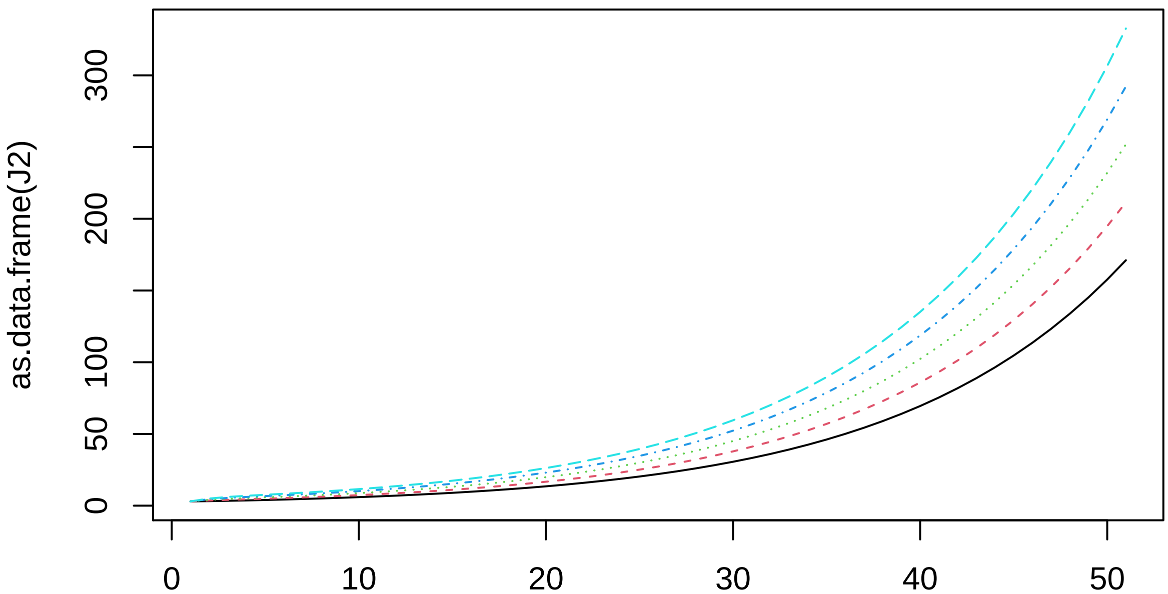

```
## integer(0)
```

Graduate students

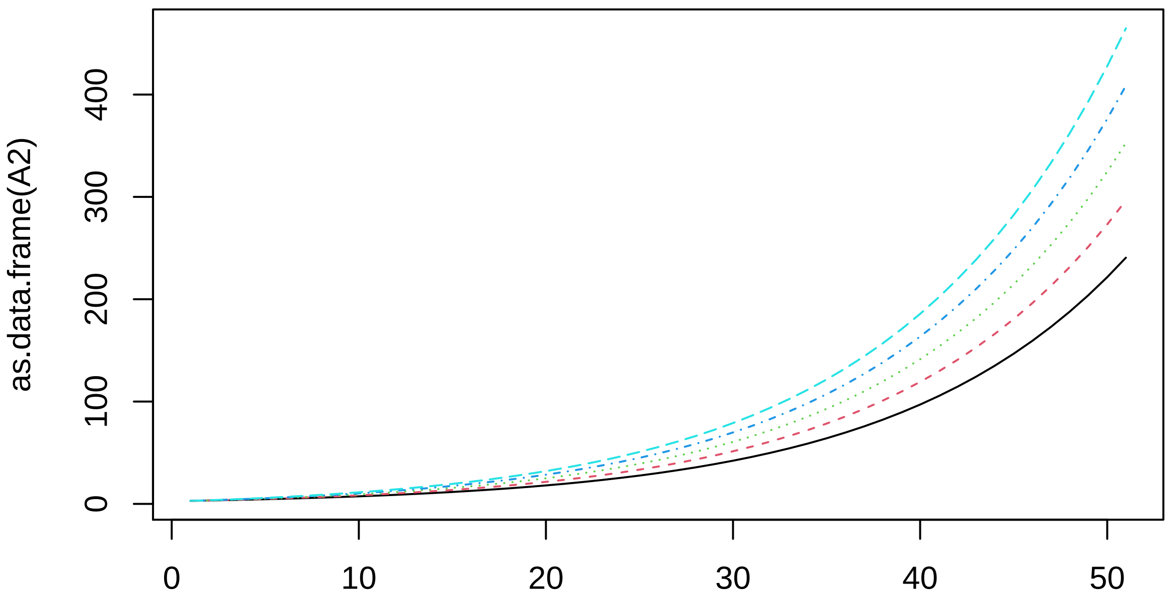
a. Provide R code demonstrating the effect.

```
J2 <- matrix(0, nrow=length(time), ncol=5)
A2 <- matrix(0, nrow=length(time), ncol=5)

# initial conditions

J2[1,1:5] <- 3
A2[1,1:5] <- 3

Im <- seq(1, 5, 1)

# solve
for(t in seq(1,length(time)-1,1)) {
  for(I in Im){
  J2[t+1,I]=(J2[t,I]+I+B*A2[t,I])*(1-M)*(1-DJ)
  A2[t+1,I]=(A2[t,I]+M*(J2[t,I]+I+B*A2[t,I])*(1-DA))
  }
}
```

```
#plot
matplot(as.data.frame(J2),type="l")
```




```
matplot(as.data.frame(A2),type="l")
```



b. Provide a short paragraph (3-5 sentences) discussing the ecological implications of increasing juvenile immigration rate.

Increasing the juvenile immigration rate increases the populations of juvenile and adult mice. This then increases the rate of growth of both populations.