

# Exercise 2.1 - Survey of ecological models, Part 1

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## Instructions

Create either an R script (.R file) or R Markdown document (.Rmd) to save all of your work for today.

## Exercise 1. Refresh your memory / repeat from last exercise

1. We will learn to write our own function - see my example here: I create a function called `my_fun`, which takes two values ( $x$  and  $y$ ), adds them together, and returns the added value.

```
my_fun <- function(x, y) {  
  z <- x + y  
  return(z)  
}  
my_fun(17, 3)
```

```
## [1] 20
```

Please choose two numbers for  $x$  and  $y$ , and use them to execute `my_fun(x,y)`.

2. Your turn! Write a function called `times_seven` - it should take a single argument, multiply that value by 7, and return the new value.
3. See the `for` loops I have written below:

```
# note how the loop changes the value of the variable x for  
# each iteration of the loop: first x=1 and 'print(x)' is  
# executed. Then x=2, then x=3, and so on.  
for (x in 1:5) {  
  print(x)  
}
```

```
## [1] 1  
## [1] 2  
## [1] 3  
## [1] 4  
## [1] 5
```

```
for (i in 1:5) {
  z <- i + 6
  print(z)
}
```

```
## [1] 7
## [1] 8
## [1] 9
## [1] 10
## [1] 11
```

```
a <- rep(NA, 5)
for (i in 1:5) {
  a[i] <- i
}
a
```

```
## [1] 1 2 3 4 5
```

```
b <- c("I", "love", "R")
for (i in 1:length(b)) {
  print(b[i])
}
```

```
## [1] "I"
## [1] "love"
## [1] "R"
```

**Your turn** - For each of three values of volume,  $v \leftarrow c(1.6, 3, 8)$ , calculate the *mass*, where  $m \leftarrow 2.65 * \text{volume} ^ 0.9$ . Please calculate this in a loop. You can print the values within the loop.

## Exercise 2. Use functions, for loops, and plotting skills to run simulation of mice in the yard

I built a function to calculate the number of mice in a yard using equation 2.4 from **Otto & Day Ch2**:

```
mice <- function(Nt,d,b,m){
  Nt1 <- (1+b)*(1-d)*Nt + m
  return(Nt1)
}
```

4. I would like you to create the following plot of mouse population size ( $N$ ) over time, using the following values for parameters:  $d = 0.7$ ,  $b = 3$ ,  $m = 4$ ,  $N_t = 42$ .



To do this, you should approach the problem in a few steps:

- Step 1. Save  $d$ ,  $b$ ,  $m$ , and  $N_t$  as their own variables.
- Step 2. Write the *mice* function.
- Step 3. Make sure the function works by calling it one time using the values given in Step 1. It should return a value for  $N_{t+1} = 54.4$ .
- Step 4. Create a new variable called  $N$ , which can hold the values generated by the function.
- Step 5. Write a *for* loop that will take the calculated value of  $N_{t+1}$ , and use it as the next time step's value of  $N_t$ . Repeat this for  $i = 100$  time steps.
- Step 6. Use R's *plot* function (or you can use *ggplot* if you like) to plot  $N$  over time.

I demonstrate how this can work below. I use a different function as an example,  $P(t+1) = \frac{bP(t)}{1+cP(t)}$ :

```
# Step 1. Example parameters
b <- 1.7
c <- .15
Pt <- 6

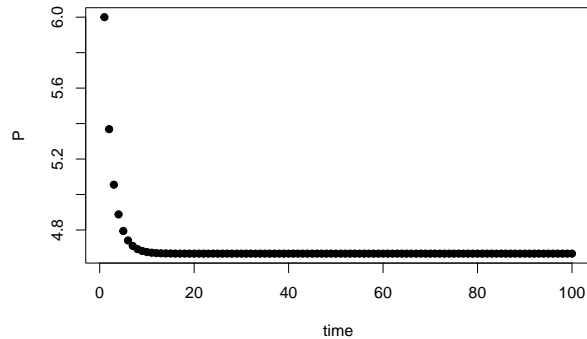
# Step 2. Example equation function
example_equation_function <- function(b,c,Pt){
  Pt1 <- (b*Pt) / (1 + c*Pt)
  return(Pt1)
}

# Step 3. Make sure the function works
Pt1 <- example_equation_function(b,c,Pt)

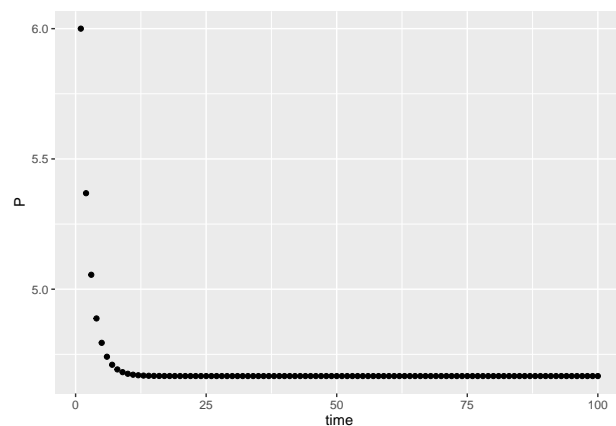
# Step 4. Create a new variable to hold future values of P
P <- rep(NA,100)

# Step 5. Create a for loop to iteratively calculate P
P[1] <- Pt
for(i in 2:100){
  P[i] <- example_equation_function(b,c,Pt)
  Pt <- P[i]
}

# Step 6. Plot P over time
plot(P,xlab="time",ylab="P",pch=19,col="black")
```



```
dat <- as.data.frame(P)
dat$time <- as.numeric(rownames(dat))
library(ggplot2)
ggplot2::ggplot(dat,aes(time,P)) + geom_point()
```



### Exercise 3. Use functions, for loops, and plotting skills to run simulation of exponential population growth

5. I show below a simulation for exponential population growth in discrete time,  $n_{t+1} = Rn(t)$ . I created the below plot of population size ( $n$ ) over time ( $t$ ) using the following values for parameters:  $R = 1.7$ ,  $N_0 = 42$ , evaluated for 100 time steps. Please create a plot for parameters:  $R = 0.7$ ,  $N_0 = 1042$ .

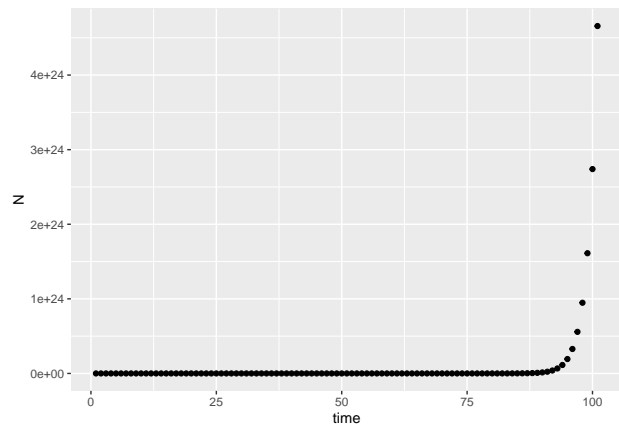
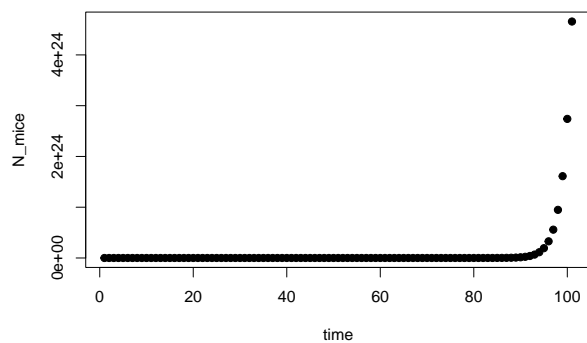
```
## Step 1. Write values for the parameters in the model
## (and initial values of state variables) R - the
## population growth rate, expressed as the number of
## individuals that replace an individual in the population
## (where R=1 is each individual replacing itself, and
## therefore no change in population size over time) --> N
## (-infinity - infinity)
R <- 1.7
# NO - the initial population size
NO <- 42
```

```
## Step 2. Write a function that will calculate values of
## number of individuals from one time step to the next.
disc_exp <- function(R, NO) {
  Nt1 <- R * NO
  return(Nt1)
}

## Step 3. Call the function disc_exp(R,NO)

## Step 4. Follow the population size over some time
## intervals N - a variable where we record the population
## size over time
N <- NO

for (i in 1:100) {
  Nt1 <- disc_exp(R, NO)
  N <- c(N, Nt1)
  NO <- Nt1
}
```



6. Please modify the simulation in #5 to create a simulation of the logistic growth model in discrete time (equation 3.5a in Otto & Day Chapter 3), using parameter values  $n_0 = 4$ ,  $K = 1400$ ,  $r = 1.21$ , evaluated for 100 time steps:

$$n_{t+1} = n(t) + rn(t)\left(1 - \frac{n(t)}{K}\right)$$

Hint: You can use the following formula:

```
disc_log <- function(r,Nt,K){
  Nt1 <- Nt + r*Nt*(1-Nt/K)
  return(Nt1)
}
```

