Homework 1

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1

Human Louse Population Exponential Growth

Given:

$$\frac{\ln \frac{N(t)}{N(0)}}{r} = t$$
$$N(0) = 10$$
$$r = 0.1$$

We solve for t:

When $N(t) = 100$:
$$t = \frac{\ln \frac{100}{10}}{0.1} \approx 23.025 \text{ days}$$
When $N(t) = 1000$:
$$t = \frac{\ln \frac{1000}{10}}{0.1} \approx 46.051 \text{ days}$$
When $N(t) = 100000000$:
$$t = \frac{\ln \frac{100000000}{10}}{0.1} \approx 161.181 \text{ days}$$
When $N(t) = 100000000000$:
$$t = \frac{\ln \frac{100000000000}{10}}{0.1} \approx 230.259 \text{ days}$$

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Human Population Exponential Growth

1. Given:

$$\frac{N(T)}{N(0)} = 2$$
$$T = 50 \quad \text{years}$$
$$N(T) = N(0)e^{rT}$$

   We set $2 = e^{rT}$, and solve for r:

$$2 = e^{r(50)}$$
$$ln(2) = ln(e)^{r(50)}$$
$$ln(2) = r(50)ln(e)$$
$$ln(2) = r(50)$$
$$r = \frac{ln(2)}{50}$$
$$= 0.0138 \text{ per year}$$

2. Given:

$$N(0) = 6.9 \text{ billion people}$$
$$T = 41 \text{ years}$$
$$r = \frac{\ln(2)}{50}$$

   We solve for $N(T)$:

$$N(T) = (6.9 \text{ billion})e^{\frac{ln(2)}{50}(41)}$$
$$N(T) = 12.18 \text{ billion humans}$$

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Annual Grass Growth

Given:

$$N(T) = N(0)\lambda^T$$
$$\frac{N(T)}{N(0)} = 2$$
$$\lambda = 1.12 \text{ per year}$$

We solve $2 = 1.12^T$ for T:

$$\begin{aligned} \ln 2 &= \ln 1.12^T \\ \ln 2 &= T \ln 1.12 \\ \frac{\ln 2}{\ln 1.12} &= T \\ T &= 6.116 \text{ years} \end{aligned}$$

4

Deaths Density Dependent/Independent

The main cause of death in my areas is heart disease. This is a density independent factor because it is caused by factors such as unhealthy diets, genetics, or inactivity, to name a few, that are unrelated to the density of the population.

Density dependent causes of death:

Disease
Competition for resources
Waste accumulation

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Koala Population Dynamics

Koala population dynamics should be modeled using a discrete model because there reproduce at the most once per year. However, the breeding season is rather long, it does occur during spring and early summer. There is a average maximum rate of growth each year, as they only reproduce once.

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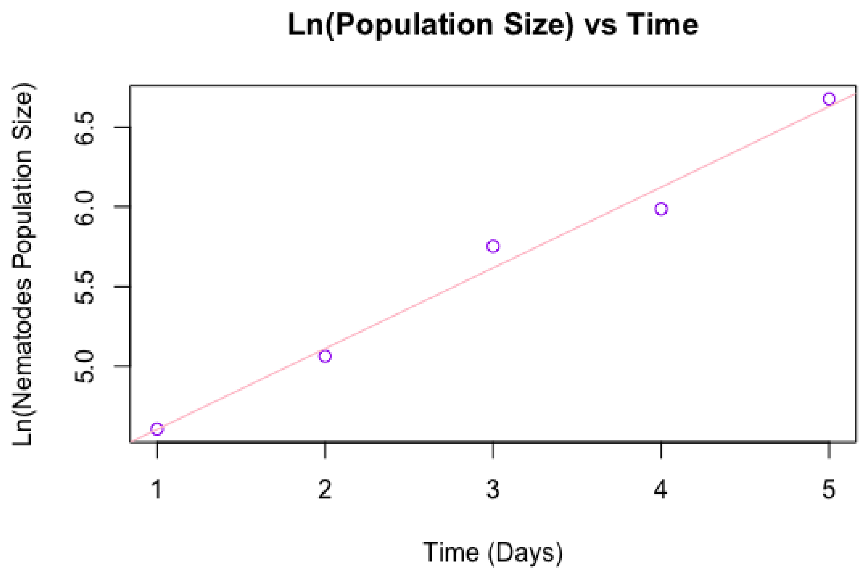
Population of Nematodes
Code: $r \approx 0.5068$

```r
# made an array that represents
#the population of nematodes over the five days
Y <- c(100, 158, 315, 398, 794)

# created an array that
#represents each of the five days
x <- 1:5

# this takes the logarithm
#(base e) of the population of nematodes
Y <- log(Y, base = exp(1))

# this calculates the estimated
#slope and y intercept of the
#best fit linear model (lm does this)
r <- lm( Y ~ x)
#Coefficients:
#(Intercept)          x
#4.0965        0.5068


# this graphs the data points
plot(x, Y, col = "purple", main = "Ln(Population Size) vs
    Time",
xlab = "Time (Days)", ylab = "Ln(Nematodes Population
    Size)")

# this adds the best fit line to the plot
abline ( r, col = "pink" )
```


Ln(Population Size) vs Time
Ln(Nematodes Population Size)
5.0
5.5
6.0
6.5
1
2
3
4
5
Time (Days)

7

Changing Per Capita Growth Rate
Code:

```
# gives dsSolve control over the script
library(deSolve)
# this is the exponential growth equation
exp.growth <- function(t, y, p) {
  N <- y[1]
  with(as.list(p), {
    dN.dt <- r * N
    return(list(dN.dt))
  })
}

# sets the function parameters
p <- c('r' = 0.25)
y0 <- c('N' = 1)
t <- 1:100

# runs and stores solution data for the ode
sim <- ode(y = y0, times = t, func = exp.growth,
parms = p, method = 'lsoda')

# changes the data to be readable by the function
sim.frame <- as.data.frame(sim)
#changes the name field of sim.frame
names(sim.frame) <- c('t', 'abundance')
#sim.frame
#sim.frame$t
#sim.frame$abundance

# this plots data for r = 0.25
plot(abundance ~ t, data = sim.frame, type = 'p',
pwd = 3, col = 'purple', bty = 'l', xlab = 'time')

# sets parameters for the new r value
q <- c('r' = .5)
# gets new ode solution
sim <- ode(y = y0, times = t, func = exp.growth,
parms = q, method = 'lsoda')
# changes data to readable
sim.frame <- as.data.frame(sim)
sim.frame
```

```
# plots new data for r = 0.5
points(sim.frame)

# sets parameters for new r value
s <- c('r' = .35)
# gets new ode solution
sim <- ode(y = y0, times = t, func = exp.growth,
parms = s, method = 'lsoda')
# changes data to readable
sim.frame <- as.data.frame(sim)
sim.frame

# plots new data for r = 0.35
points(sim.frame, col = 'green')

#to create legend
v <- strwidth('purple r = .25')
legend(5,5e+10,c("r =.25", "r =.5", "r =.35") ,
text.width = v, lty=c(1,1,1), title = "Legend",
lwd = c(5.0, 5.0, 5.0),
col = c("purple", "black", "green") )
```