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April 7th, 2016
Homework #1
BI 471

1. $$N(t)= N(0)e^{rt}$$

$$N(t)/N(0)= (N(0)e^{rt})/N(0))$$

$$N(t)/N(0)= e^{rt}$$

$$\ln(N(t)/N(0))= \ln(e^{rt})$$

$$\ln(N(t)/N(0))= rt*\ln(e)$$

$$\ln(N(t)/N(0))/r = (rt*(1))/r$$

$$\ln(N(t)/N(0))/r = t$$

If r =0.1 per day and N(0) = 10 then let's solve for the following t's when N(t)=[100,1,000, 1,000,000, 1,000,000,000]

[100]

$$t = \ln(N(t)/N(0))/r$$
$$t = \ln(100/10)/0.1$$
$$t = 23.03 \text{ days}$$

[1,000]

$$t = \ln(N(t)/N(0))/r$$
$$t = \ln(1{,}000/10)/0.1$$
$$t = 46.05 \text{ days}$$

[1,000,000]

$$t = \ln(N(t)/N(0))/r$$
$$t = \ln(1{,}000{,}000/10)/0.1$$
$$t = 115.13$$

[1,000,000,000]

$$t = \ln(N(t)/N(0))/r$$
$$t = \ln(1{,}000{,}000{,}000/10)/0.1$$
$$t = 184.21$$

Given that the reproduce rapidly and are small organisms its interesting to think of what a perfect environment would be for an actual growth rate to occur like this. Most often growth rates are limited by the resources available to the population.

2. If the world's human population is to be considered in a continuous model we will be using the formula:

$$N_t = N_0\, e^{rt}$$

We can assume that N_t is the population that is twice the size of N_0 when t = 50. This is useful when trying to solve for r:

$$N_t = 2*N_0 \text{ , when } t = 50$$
$$2*N_0 = N_0e^{r(50)}$$

$$2 = e^{r(50)}$$
$$\ln 2 = \ln(e^{r(50)})$$
$$\ln 2 = r(50)$$
$$r = \ln 2/50$$

So if we try to solve for N_{2050} when the starting population is 6.9 billion in 2009 (N_{2009} = 6.9 million people) then we can solve with this theoretical r value.

$$N_{2050} = N_{2009}e^{(\ln 2/50)*(2050-2009)}$$
$$N_{2050} = 6.9* e^{(\ln 2/50)(41)}$$
$$N_{2050} = 12.18 \text{ billion people}$$

3. Using the population doubling rate formula:

$$T_d = \ln(2) / (\ln(1+(r/100)))$$

Where T_d is the number of years it takes for the population to double and r is the percent at which the population growth (population growth rate) such that 12% means that r = 12.

$$T_d = \ln(2) / (\ln(1+(12/100)))$$
$$T_d = 6.116 \text{ years}$$

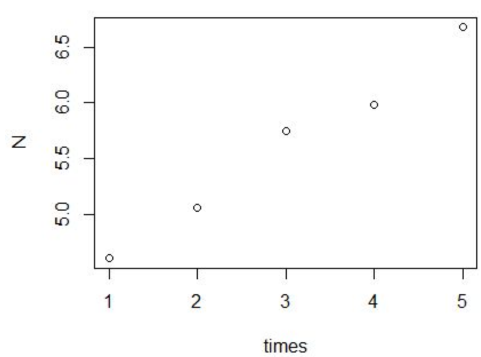
4. Economy has a huge impact on the model at which human populations grow. Most countries with high birth rates often are so due to the high death rates due to lack of sanitation and effective medical treatment. In countries like the United States families tend to be smaller and population growth tends to be mitigated by ability to support a family rather than for the sake of mating. Deaths are usually caused by auto accident which is rarer than starvation or poor working conditions that might cause death in poorer countries, and so death rates are low.

5. DID IT: Elephants!

6. I was able to plot the data points relatively easily

```
> times<-1:5
> N<-log(c(100,158,315,398,794))
> plot(N~times,)
```

But I had trouble using the `lm` function. I couldn't seem to figure out how to input the necessary `formula` or what `na.action` is.



7. I tried using the ODE code and was able to successfully install it, but I ran into an issue writing the function for `exp.grwth` :

```
> exp.grwth<-function(t,y,p){N<-y[1]
>+ with(as.list(p),{
>+     dn.dt<-r*N
>+     return(list(dN.dt)})}
>Error: unexpected '}' in:
>"    dn.dt<-r*N
    return(list(dN.dt)}"
```

I tried several times and couldn't get it (I was working on a PC and not a mac if that helps). I think I need more time with the program in order to fully understand it as a tool. I will be coming into office hours to get more help in the future.

In order to answer the question though:

t = 100, r = 0.25, and N(0) = 1, using:

$$N(100) = N(0)e\text{^}rt$$

$$= (1)e^{(0.25)(100)}$$

$$= 7.2*10^{10}$$

t = 100, r = $3.14159265359^{-3.14159265359}$, and N(0) = 1, using:

$$N(100) = N(0)e\text{^}rt$$

$$= (1)e^{(0.0274)(100)}$$

$$= 15.5$$

t = 100, r = 1, and N(0) = 1, using:

$$N(100) = N(0)e\text{^}rt$$

$$= (1)e^{(1)(100)}$$

$$= 2.67*10^{43}$$