**Computer lab continued - problem 2.13**

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**Warm up exercise ??**

**General comments**

Watch out for units: e.g., problems 5 (unitless) and 7 (kg).

9. \( A_0 \) the age at the depth defined as 0. It does not have to be the age of the present-day depositional surface. In this problem \( A_0 \) also represents the time it takes to fill up the lake.

The present-day depositional surface may be located at some arbitrary depth: in this case 11.5 meters.
General comments

13. \( \log N = -bm + c \)

In this expression \( N \) is the number of earthquakes of a given magnitude (m) and greater likely to occur in a given year (units = \( \text{yr}^{-1} \) or earthquakes per year).

To determine the probable length of time in years between events with magnitude \( m \) and greater you need to compute \( 1/N \) which gives you a result in years/earthquake.

Consider the units.

\[
y = \sin(5x)
\]
Evaluate the logs of these two functions

What base do you need to use?

\[ A = A_0 e^{ad} \quad \text{or} \quad A = k d + A_0 \]

Age – Depth relationships? \[ A = A_0 e^{ad} \quad \text{or} \quad A = k d + A_0 \]
Time-depth relationships can often be broken down into a series of linearly varying age-depth relationships.

Again – this data from the Atlantic shelf margin does not suggest exponential age-depth relationships.

In this plot we see slope = rate. In this plot we see slope = rate\(^{-1}\).
Visit http://curvebank.calstatela.edu/radiodecay/radiodecay.htm

\[ a = a_0 e^{-\lambda t} \]

Plot of carbon-14 decay rate against age of the sample in years.

How could you figure the half-life?
Some other geologic variables also have exponential dependence on depth, for example.

\[ e^{-cz} \]

\[ \text{Porosity} \]

\[ \text{Bulk density (g cm}^{-2}\text{)} \]

\[ \propto 1 - e^{-cz} \]

See Nittrouer et al., 2008

http://www.otherwise.com/population/exponent.html

Otherwise

Exponential Growth

If a population has a constant birth rate through time and is never limited by food or disease, it has what is known as exponential growth. With exponential growth the birth rate alone controls how fast (or slow) the population grows.

Click the following button to run an applet you can use to experiment with exponential growth. If you are accessing this Internet site via a slower network connection it may take several seconds for the applet to appear.

Run applet

The applet shows a habitat containing two fish. Near the top of the window on the left is shown what generation we are in and on the right the population size is shown. Underneath the habitat are an area where you can enter the average population birth rate. This rate is initialized to 1.5.

Near the bottom of the window are four buttons used to control the simulation. By clicking the Step button you can have the population "step" through one generation of time and see how many individuals are in the population in the next generation. Clicking the Run button will automatically step a generation every second and the button will change to say Stop. Using either button try stepping through 20 generations and observe the results.
Problem 2.13 \[ \ln(a) = \ln(a_0) - \lambda t \]

Take the natural log - ln

\[ a = a_0 e^{-\lambda t} \]

Consider the inverse process: take e to the power of the natural log

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Check-off list for this assignment:

- **2 points**: Your work should include a statement of the problem and the value(s) to be determined.
- **4 points**: Submit an Excel plot of $\ln(\lambda)$ vs. $t$ and include your name in the Chart Title.
- **2 points**: On your chart locate the point with value $\ln(100)$. Extend a line down from the appropriate point on the curve to the t-axis and note the value of $t$ corresponding to $\ln(100)$. You can draw the line in pencil if you wish.
- **4 points**: Show the numerical details of the computation of $\ln(100)$, i.e.,
  \[ t = \frac{\ln(1000) - \ln(100)}{1 - \frac{\lambda}{c}} \]
  \[ = \frac{[\ln(1000) - \ln(100)]}{10^3} \]
- **2 points**: Submit an Excel plot of $a = a_0 e^{-\lambda t}$.
- **2 points**: On your chart locate the point with value $a = 100$ rps. Just as in question 2, note the value of $t$ at which the radioactivity drops to 100 rps.
- **4 points**: Specifically write the results of your analysis in sentence form.

Total 26 points
• Hand in problems 2.11 and 2.12 Today
• Have questions ready on 2.13 for Monday
• Read through Chapter 3. Try to work through the discussion questions as you read.
• Consider Problems 2.15, 3.10 and 3.11
• No class next Thursday!

Problem 2.13 deals with exponential decay formulation. This class of functions is used for dating a variety of geological materials and is very familiar to geologists.

$^{210}\text{Pb}$ dating  
22.3 year half life

Stalagmite from cave in France