M111 Math as a Human Pursuit Lab Semester 091

Cane Toad Population Growth Lab Name _____

From 1935-37, the American marine toad -- also called the Cane Toad --(*Bufo marinus*) was introduced into Queensland, Australia in eight coastal sugar cane districts. Due to lack of natural predators and an abundant food supply, the population grew and the highly poisonous toads began to be found far from the region in which they were originally introduced. Survey data presented by J. Covacevich and M. Archer ("The distribution of the cane toad, *Bufo marinus*, in Australia and its effects on indigenous vertebrates," *Mem. Queensland Mus*,**17**: 305-310) shows how the toads expanded their territorial bounds within a forty-year period. The assumption is that the population is proportional to the area occupied.

Year	Area Occupied (square km)
1939	32,800
1944	55,800
1949	73,600
1954	138,000
1959	202,000
1964	257,000
1969	301,000
1974	584,000

1. We are going to use Logger Pro software to find the best fitting exponential curve for this toad data and then use it to predict future growth. The primary reason we are using Logger Pro is to become familiar with its interface for some experiments we will be doing.

2. First save the following "Experiment File" for Logger Pro that has the above toad data already entered in it. (Right click on this link ToadPop-091.cmbl and chose "Save Link Target As" – then save the file to the N: drive).

3. Start **Logger Pro** by clicking on the Logger Pro 3.7 icon (on the laptops, this icon is on the desktop and on the Core 108 lab computers it is in the Math folder).
(Close Tip of the Day if showing, and then Click on "Continue without interface")

4. Choose **Analyze – Curve Fit.** Select **Manual** on the **Fit Type.** Click on **Define Function** and then press enter. Into the box labeled Define User Function **type "P*(1+r)^x", enter the name as "expon"** and click on OK. Then in the boxes to the right enter the values: **32800** for **P** and **0.05 for r.** Then click on OK

5. You can see that the curve does not have a good fit since the rate .05 is not fast enough.
To delete the curve click on the x on the floating box that labels the curve.

6. Choose Analyze **– Curve Fit**, the function **P*(1+r)^x** and enter the same value for (32800), but a different value for r. (You can use the up and down arrows by the r parameter until you think the curve is a good fit – set step size to 0.01 first). You should see a value for RMSE in the lower right of the window. The RMSE (Root Mean Square Error) is a measure of how far away, on average, the data points are from the fitted curve. RMSE is in the units of the y-axis (toads in our case). Try to get the smallest value for RMS (root mean square error) that you can.
Write down the resulting equation that you decide upon:

7. Now choose Analyze – Curve Fit, the function **P*(1+r)^x**, and click on the Automatic option, then choose OK. This has Logger Pro choose the best fitting curve (-- in terms of a least squares fit -- the one that minimizes the sum of the squares of the vertical distances of the points from the curve.)

a) Write down the equation that Logger Pro chooses as the best fit for the data:

b) Using this model of exponential growth what should the population be in the year 2009? (use your calculator or Maple).

c) What should the population be in the year 2039 according to this growth pattern?

d) Check your answers to the above questions in step 6 by choosing Analyze – Interpolate. Then move the mouse to the right until you find year 2009 (Elapsed time = 70) and read the corresponding value for the Toad Population. Write down the predicted population:

e) Repeat for the year 2039 (Elapsed time = 100). Write down the predicted population:

8. Delete the fits that you made by clicking on the x-button (close) on the floating box with the curve.

9. The data from the years 10 to 30 (1949 to 1969) seem to be linear. Try a linear fit for to this range of data:
a) (Zoom back in first). Select these data points by **dragging the mouse pointer across the region from time 10 to time 30** (The region will be shaded gray) Then choose **Analyze – Linear Fit.**

b) Write down the equation for the line represented by this fit.

c) There are two measures displayed the goodness of linear fit **RMSE** and **correlation**. Correlation is always between -1 and +1. Perfect positive linear correlation would have a value of 1. Perfect negative correlation would have a value of -1. Positive correlation exists between two variables if they tend to move in the same direction, negative correlation exists if they tend to move in the opposite direction (e.g. if we had a declining toad population.)

Write down the correlation shown:

Write down the RMSE shown:

d) What would the population be in the years 2009 and 2039 respectively if the growth fit this linear curve?

Check your answer by using the Analyze – Interpolate again as before.

10. To save your experiment file, choose **File – Save** and to exit LoggerPro, choose **File – Exit.**