Assignment #3

Due on Wednesday, February 3, 2010

Read Section 1.1 on *The Malthusian Model,* pp. 2–5, in Allman and Rhodes.

Read Section 1.2 on *Nonlinear Models,* pp. 11–17, in Allman and Rhodes.

Do the following problems

1. Problem 1.1.11 on page 8 in Allman and Rhodes.
2. Problem 1.2.7 on page 18 in Allman and Rhodes.
3. Problem 1.2.8 on page 18 in Allman and Rhodes.
4. *(US Census Data.)* The MS Excel file CensusDataUS in the Math 36 webpage (see the courses website at `http://pages.pomona.edu/~ajr04747`) contains the total US population (in millions of people) for each year that a census has been taken in the United States.

   (a) Use MATLAB® to get a plot of the US population as a function of t, where t is in units of 10 years since the year 1790.

   (b) If the US population follows a Malthusian model, what would the growth rate λ be? Using this value of λ, compute the population values that the model predicts for $t = 1, 2, 3, \ldots$ Plot the predicted and actual values on the same graph. How well do these predictions compare with the actual data?

5. *(US Census Data, continued).* Starting with the solution to the Malthusian model: $N_t = N_0\lambda^t$, take logarithms on both sides to get

   $$\ln N_t = \ln N_0 + t \ln(\lambda).$$

   Thus, the relationship between $\ln N_t$ and t should be linear with slope $\ln(\lambda)$ and y–intercept $\ln N_0$.

   (a) If `X` represents a row of values, and `Y` another row of values of the same size, the MATLAB® function `polyfit(X,Y,1)` returns the slope m and y–intercept y_o of the line that best fits the data (in the sense of least squares regression) in `X` and `Y`: $y = mx + y_o$.

   Use this function to obtain estimates for the values of $\ln N_0$ and $\ln(\lambda)$

   (b) Obtain estimates for N_0 and λ, and use them to generate a new set of predicted values for the US population. Plot these, along with the actual data, and assess how good the fit is.