III. LINEAR LEAST-SQUARED FIT: GLOBAL TEMPERATURES

Physics 580, SDSU. Due 11:59 pm, Friday, October 21, 2011

You have just been hired at the National Oceanographic and Atmospheric Administration (NOAA) to analyze climate data. You are given data (see below) to try to model. You decide to do a linear least-squares fit using a polynomial. Whether or not a polynomial is the best choice is a topic beyond this project.

The data is in the form of the year y, the temperature $T(y)$, and the error on the temperature measurement $\sigma(T(y))$. Find the best fit function,

$$T(y) \approx \sum_{\alpha=1}^{k} c_\alpha g_\alpha(y), \tag{3}$$

where the $g_\alpha(y) = y^{\alpha-1}$ are the polynomials for the fit.

A. Basic Project (worth 75%)

Fit the data (without the error bars) with a quadratic (that is, $k = 3$, $T(y) = c_1 + c_2 y + c_3 y^2$). To make your calculations more stable, use $y = \text{year} - 1900$ (and then add back the 1900 when plotting the results). You can find data alongside the project assignment writeup. Use the data set that corresponds to the last digit of the date of your birth. All data sets have solutions, but some "realistic" noise has been added to the data. Remember when reading in your data that uncertainties on the temperature measurements are also included.

You may use, without penalty, the matrix inversion subroutines from Numerical recipes, and examples on their use can be found on the course webpage.

For full credit, your program should be well-commented, and the input/output clear and easy to use. You should design how to input the data; the best method is to have the code read in the data file, rather than typing it in by hand. You may use, without penalty, the parts of the code in `matrixexample.f`, available on the course webpage on the course website, for reading information from a file.

B. Advanced project (worth 25%)

Recompute the coefficients for the polynomial using the error bars. Also, try polynomials of different degree (*e.g.*, third order, fourth order, ...). Which one is the "best" and why? Include your answer in a text file along with the submission. **Extra Credit:** extrapolate (with error bar, mandatory) the expected temperature in 2050.

C. Notes

As before, name your program with your last name and project number, and tar the files together for submission. Be sure to include all the files necessary to compile and run, including those you may have used from the course webpage. Also, include a text file that has all your solutions for the coefficients of the polynomials that you have completed as a part of this project. Finally, include a plot (.ps or .eps) that shows your data (with error bars) and the line for the best polynomial fit.