AUMAT/AUCSC/AUPHY 340 – Numerical Methods

Winter 2019

Project

Submission deadline: Monday, 08 April 2019, 8:30am (by email)

Consider the following global temperature record:
"Land + Ocean (1850 – Recent)" at http://berkeleyearth.org/data/
Choose the ***annual summary*** and read the description of the data set carefully.

Now, consider the annual anomaly for the case that, according to the authors, is more meaningful. You will now use this data set and extrapolate the data to the year 2100 to see what temperature anomaly we might be expecting by then. We assume that we have no better way to estimate the situation in 2100 than by way of extrapolation. The main point of this project is to assess how different fit functions will result in different estimates and, hence, how robust such a forecast might be.

Write a report (including Matlab code(s) and figures), preferably in Latex but Word would also be acceptable, that includes the following:

1) A linear fit to the data set: $p_1(t) = a_1 + b_1 t$
2) A quadratic fit to the data set: $p_2(t) = a_2 + b_2 t + c_2 t^2$
3) A cubic fit to the data set: $p_3(t) = a_3 + b_3 t + c_3 t^2 + d_3 t^3$
   Make sure that you state the equations (linear system) for this case explicitly in the report.
4) An exponential fit to the data set: $p_e(t) = c + a e^{bt}$
   Here you are encouraged to use a built-in Matlab routine: lsqcurvefit
   https://www.mathworks.com/help/optim/examples/nonlinear-data-fitting.html
5) In all cases, compute the residual (error) of the approximation, i.e. the sum of the squares of the differences between data point and function value, taken at all times of the data set.

A key step is to read the data set into your Matlab code. One way is to copy and paste it into Matlab to define a matrix. Another, more elegant way is to save it first as an external file and then read that file into Matlab. Each method is fine.

For 1)-3), define the set of linear equations in Matlab, i.e. compute the coefficients of the matrices and the vectors in Matlab.

In your calculations, re-define 1850 as $t = 0$.

Your report should be self-contained, i.e. it should include a description of the problem, the questions we like to answer, the answers to the questions, the Matlab codes, the figures, and the interpretation of the results.

Bonus marks
Bonus marks can be obtained for the following:

1) Writing the report in Latex.
2) Using an additional fit function of the form $p_{mix}(t) = a + p(t)e^{\beta t}$, where $p(t)$ is a polynomial of order 1 or 2, including a corresponding number of parameters. Again, lsqcurvefit can be used.

BE CREATIVE!