EP 501 Homework 2: Nonlinear Equations and Root-finding

October 22, 2019

Instructions:

- Submit all source code and publish Matlab results in .pdf form via Canvas. Please zip all contents of your solution into single file and then submit in a single zip file.
- Discussing the assignment with others is fine, but you must not copy anyone's code.
- I must be able to run your code and produce all results by executing a single top-level Matlab script, e.g. assignment1.m or similar.
- You may use any of the example codes from our course repository: `https://github.com/mattzett/EP501/`.
- Do not copy verbatim any other codes (i.e. any source codes other than from our course repository). You may use other examples as a reference but you must write you own programs (except for those I give you).
- For demonstrating that your code is correct when you turn in the assignment, you must use the test problems given in the assignment text below.

Purpose of this assignment:

- Learn principles behind data fitting and polynomial approximation.
- Develop good coding and documentation practices, such that your programs are easily understood by others.
- Hone skills of developing, debugging, and testing your own software
- Learn how to build programs on top of existing codes

1. Least squares and data fitting: this problem requires use of the example dataset from the repository.

   (a)

2. Bilinear interpolation: this problem requires use of the grid and data from the repository.

   (a) Write a function that takes in a grid of points describing some independent variable (say x_i), and a point to which the data are to be interpolated x' and finds the index i into the array x_i such that: $x_i \leq x' \leq x_{i+1}$.

   (b) Use the function from part (a) to construct an additional function that works over a 2D grid x, y. I.e. given two grids x_i, y_j find the indices i, j such that: $x_i \leq x' \leq x_{i+1}$ and $y_j \leq y' \leq y_{j+1}$.

   (c) Use your results from parts a and b to create a bilinear interpolation function that takes in a sequence of data points $\{x'_k, y'_k\}$ to which data are being interpolated, a grid x_i, y_j, and a dataset f_{ij} that is defined over this grid and produces bilinearly interpolated values of f at the points $\{x'_k, y'_k\}$. Write your program so that the input points are simply a flat list and no necessarily a 2D grid of points.

   (d) Test your results against Matlab's bilinear interpolation function and show that you get the same result.