Phys 331 - Numerical Techniques for the Sciences I.
Homework 10: Linear Regression and Deep Learning

Posted November 17, 2024
Problem 1 Due November 25, 2024
Problem 2 Due December 1, 2024 (plus in-class presentation December 2).

Problem 1: Fitting Lines and Power Laws to Data [30 pts]

Using the template `problem1.ipynb`, write a program called `linear_regression` to perform the least-squares linear regression from class. Your code should take in two arrays corresponding to the x and y data points from the provided files, and return two numbers, β_0 and β_1, corresponding to the y-intercept and slope of the line that minimizes the sum of the squared errors. You should also write a program, `r_squared`, that computes the R^2 value for the fit.

(a) *Fitting a Line* – Use the function `load_linear_data` to read in the data for the linear data. Using your linear regression function, calculate the values of β_0 and β_1 for the fit:

$$y = \beta_0 + \beta_1 x \tag{1}$$

Plot your best-fit line and a scatter plot of the data, and compute the R^2 value of your fit.

(b) *Fitting a Power-Law* – Use the function `load_powerlaw_data` to read in the data for the linear data. Using your linear regression function, calculate the values of β_0 and β_1 for the fit:

$$y = \beta_0 x^{\beta_1} \tag{2}$$

by taking the log of both sides and computing the linear regression in $\log(y) - \log(x)$ space. plot your best-fit power-law and a scatter plot of the data, and compute the R^2 value of your fit.

Problem 2: Open-ended [20 pts]

This is an open-ended problem: using ChatGPT (or your favorite generative-text AI), you should pick one of the computational assignments from this semester, and ask ChatGPT to provide you with a function to solve one of the given homework problems.

You may pick any one of the following algorithms from this semester:

- `rf_bisect` from HW02
- `rf_newton2d` from HW03
- `triSolve` from HW05
- `sdft` from HW07
- `rk4step` (with the stepping routine `ode_fixedstep`) from HW08

Rather than write up the solution, I want you to create **1 slide** that shows how ChatGPT's algorithm compares to your own. How to demonstrate this is up to you: code comparison (show us what it did versus what you did), plot (your solution vs its solution side-by-side), numerical figure-of-merit (i.e. single number). Up to you!

This assignment will be turned in in Canvas in one of two ways: either use the attached PowerPoint Template, or a link to a Google Slide.