Chapter 7 & 8 Exercises

Instructions: Complete the following exercises using Python 3. You may work with up to one other person. You may use library packages unless you are explicitly told not to. If a problem tells you to write a program/function for arbitrary input, you should always test your function and ensure it works. If you are stuck or need any help, please do not hesitate to ask the instructor or teaching assistant.

1) Write a function that performs linear least squares regression, as described in section 7.1. Additionally, have your function calculate and return the R^2 value.

2)You will be given a data set titled Data_CH7_p2. Read the data into Python and graph it. Using the function you write in problem 1), fit a line to this data. Overlay your model on your plot. Make a second plot of the data and use curve_fit() to fit a line to it. In both cases, place the values of the fit parameters neatly under the appropriate plot to 3 decimal places. Compare the values of the fitted parameters between the function you write and SciPy's curve fit. Are they similar? If not, you should check the function you wrote in problem 1) and the syntax you fed to curve_fit(), as there's a mistake somewhere.

3) You will be give a data set titled Data_CH7_p3. Read the data into Python and graph it. Using curve_fit(), fit a a model to the data. Plot your model over the data and print each fit parameter and their uncertainties to 3 decimal places. Display these fit parameters underneath your graph as a caption (*Hint*: You want to plot a decaying sinusoidal function.)

4) You will be given a data set titled Data_CH7_p4. Read the data into Python and graph it. This is data of a ball bouncing. Fit a parabola to each complete individual parabolic curve in the data set. Using your fit, calculate the acceleration due to gravity, g, for each parabola. Compute the average value of g and the standard deviation. Compare it to the accepted value of g. If we define the percent error as

$$\%\ \text{error} = \left|\frac{\text{experimental}\quad\text{value} - \text{theoretical}\ \ \text{value}}{\text{theoretical}\quad\text{value}}\right|$$

what is the % error?

5) You will be given a data set titled Data_CH8_p1. It contains data on time, velocity, and the uncertainty of the velocity. Read all three columns into Python and plot the data *with error bars*. Use curve_fit() to fit a line to the data, making sure that fit accounts for uncertainties. Print the results and error of the fit to 3 decimal places. Using the formula given in equation (8.2) for linear interpolation, perform linear interpolation on the data set, making an interpolated data point at the midpoint between every existing data point. Using

SciPy, fit a line to this interpolated data and print the fit parameters. Compare the fit parameters and comment on whether or not they are different. Finally, plot the raw data and uncertainties and the interpolated data on a separate plot.

6) You will be given a data set titled Data_CH8_p2. Read the data into Pythona and make a plot of the time column against the s1(t) column. Use linear interpolation to thin the data by calculating the interpolant (interpolated data point) between two data points every 1) 1 second and 2) 10 seconds. In both cases, plot the interpolated data and raw data on the same graph (for a total of two graphs). Note that this is a large data set, so you will need to write an efficient algorithm to interpolate all of the data points.