PHYS 310 — Homework #4

Reading:

- Review Hughes & Hase Chapter 5 (you were asked to read this after Homework 3)

- Read sections 6.1–6.4

- Future Homework: Before the next class: Finish Hughes & Hase Chapter 6

Note that these problems, and the data for the problems, are available at
`www.eg.bucknell.edu/~phys310/hw/assignments/hw4.html`.
Please submit your work in your course folder.

1. Download the file `hw4-1.dat` This file contains data from 20 experiments that nominally measure the same quantity. Each line contains the measured value and the uncertainty in that measurement. Use these data to answer the following questions:

   (a) What value do you quote for this quantity based on the data? (That is, include the uncertainty.)

   (b) Each data point has its own uncertainty α_i. How many of the data points lie within $1\alpha_i$ of the mean value you determined?

   (c) What is the goodness-of-fit parameter χ^2 for this data set and model? (Note: In this case, the function $y(x)$ is just the constant value of the mean you determined.)

2. Download the file `hw4-2.dat`. These data come from an experiment in which there is a suspected linear relationship between measured values of x and y. The data for each measured point are on a single line in the file. The first number on each line is the value of x, the second is the value of y, and the third is the uncertainty in the measured value of y. Uncertainties in x are negligible. Use these data to do the following:

   (a) Perform a fit to these data using the generic `optimize.curve_fit` routine from `scipy` that we demonstrated in class. Plot the best-fit line along with the data.

   (b) Plot your normalized residuals. How many of the data points lie within 1α of the line you determined?

(c) Determine the goodness-of-fit parameter χ^2 for this data set and model.

(d) Given your analysis, does a linear fit to the data appear to be reasonable? Comment briefly.

(e) What value do you quote for the slope and intercept based on the data? (Include uncertainties.)

3. Download the file `hw4-3.dat`. These data come from an experiment in which the relationship between x and y is suspected to be $y = a_1 \sin(2\pi x) + a_2 \sin(4\pi x)$ where a_1 and a_2 are the parameters to be determined. The data for each point are on a single line: the first number is the value of x, the second is the value of y and the third is the uncertainty in the value of y. Uncertainties in x are negligible. Use these data to do the following:

(a) Is the suspected relationship between x and y a linear model, or a nonlinear model?

(b) Perform a fit to these data using the generic `optimize.curve_fit` routine from `scipy` that we demonstrated in class, using the assumed functional form shown above.

(c) Plot your residuals.

(d) Determine the goodness-of-fit parameter χ^2 for this data set and model.

(e) Given your analysis, does your fit to the data appear to be reasonable? Comment briefly.

(f) What are your resultant values for a_1 and a_2? (Include uncertainties.)