8

Fitting

(2012 – 2013 Academic Year: Tutorial Questions)

Exercises

8.1 When might it be useful to perform a fit to data?

8.2 Explain the term "number of degrees of freedom" and how this relates to the number of data N in a data set.

8.3 Given the measurements $x_1 = 1.2 \pm 0.3$, and $x_2 = 1.8 \pm 0.3$, approximate the mean value and uncertainty on the average value of x obtained by performing a χ^2 scan from 1.0 to 2.0 in steps of 0.1. Compare the results you've obtained with those from a weighted average (see tutorial on errors, question 8).

8.4 Assuming that $y = ax^2 + b$, use the method of least squares to derive the values of a and b. Assume that the uncertainties on each of the data points is the same.

8.5 Use the method of least squares, assuming the relationship $y = ax + b$, to determine the values and errors associated with a and b given the data below, assuming that the uncertainty $\sigma_y = 0.1$.

x	1.1	1.5	2.0	3.1	4.2	5.0
y	2.0	2.9	4.2	6.0	8.0	10.0

8.6 By performing a χ^2 scan, estimate the average value of the following measurements of the quantity S: 0.655 ± 0.024, 0.59 ± 0.08, 0.789 ± 0.071. Hint: You might like to assume a bin spacing of 0.01 and consider the range $S = 0.6$ to $S = 0.7$.

8.7 Given two measurements of some observable x,

$$x_1 = 1.3 \pm 0.1, \tag{8.0.1}$$

$$x_2 = 1.1 \pm 0.2, \tag{8.0.2}$$

estimate the best fit for the average value of x_1 and x_2 by performing a χ^2 scan in steps of 0.05 from $x = 1.1$ to $x = 1.4$, and estimate the the error on the average value. Note the χ^2, and the corresponding $P(\chi^2, \nu)$ for your result, and comment if this is reasonable.

8.8 If a $-\ln \Delta\mathcal{L}$ curve is given by $1.1(x - 1.3)^2$, what is the central value and uncertainty on the best fit result obtained?

8.9 If a $-\ln \Delta\mathcal{L}$ curve is given by $0.5(x + 2)^2$, what is the central value and uncertainty on the best fit result obtained?

8.10 If a $-\ln \Delta\mathcal{L}$ curve is given by $(x - 1)^2$, what is the central value and uncertainty on the best fit result obtained?

8.11 Hooke's law is given by $F = -kx$, where F is force in Newtons, and x is the elastic extension in cm. Given the following data for a spring under load, determine the best fit value for the constant of proportionality k, assuming the uncertainty on x_i is constant.

F	1.0	2.0	3.0	4.0	5.0
x	0.4	1.1	1.5	2.1	2.5

8.12 Ohm's law is given by $V = IR$. Given that current is measured by a precise device, and that $\sigma_V(I)$ is a constant, determine the general expression for calculating R for a data sample using a least squares approach.