Data Analysis - 2020

Exercise sheet no 5: 10. November 2020
The least squares method

- `scipy.optimize.curve_fit`

Exercise 1: Least squares fit using Ohm's law (20 Points)

The file `current_measurements.txt`, contains a set of 6 measurements of the current as a function of the voltage to measure the resistance, R. The first column is the voltage value, the second column is the current value and the third column is the uncertainty on the current.

(a) Plot the current measurements with error bars as a function of the voltage.

(b) Write a function which calculates the χ^2 value for the dataset as a function of the resistance, R. The fitted function should be Ohm's law.

(c) Plot this χ^2 function as a function of the resistance and use the plot to find the minimum value of the χ^2 and best fit value of R.

(d) Overlay the best fit function on your plot of the measurements. Does it look like a good fit?

(e) Calculate the uncertainties on R by using the $\Delta(\chi^2) = 1$ rule. Is the value compatible with the known value of $R = 2\,\Omega$?

(f) Modify your χ^2 function to add a fixed offset parameter $\epsilon_{bias} = 0.7\,A$ as shown in the lecture and recalculate the best fit R value with its uncertainty. Is it now compataible with $R = 2\,\Omega$?

(g) Compare the χ^2/ndf with an without the bias offset and calculate the goodness-of-fit probability for both cases.

(h) Use the `scipy.optimize.curve_fit` method to optimise both the R and ϵ_{bias} parameters simultaneously.

(i) Use the covariance matrix returned by the `scipy.optimize.curve_fit` to calculate the uncertainties on R and ϵ_{bias} and their correlation coefficient. How does the uncertainty on R compared to your answer in f)?

Deadline for submission: Friday, 20. November 2020 14:00
Form: Please submit your solutions to da@physik.uzh.ch. The solutions should be submitted as a single python script with answers to specific questions in the comments.