Data Analysis - 2020

Exercise sheet no 4: 27. October 2020
Error propagation

Exercise 1: Error propagation (4 Points)

You have been asked to determine the length, L, of the side of a cube. For simplicity, you assume that all sides have the same length. To do this you measured the volume, V, such that $V = 4\ \mathrm{cm}^3$.

- How big can the absolute uncertainty on your measurement of the volume, V be such that you obtain a measurement of the length, L, with a relative precision of 3%?
- How does the answer change depending on whether the uncertainty on the length is statistical or systematic in nature?

Exercise 2: Error propagation with correlated variables (6 Points)

The dataset in `/disk/puma/da/uebg/sand.txt` or on the course webpage reports the slope of a beach (2^{nd} column) as a function of the diameter of its sand granules (in mm) (1^{st} column). The third column reports the uncertainty on the slope.
Assuming a simple linear relation between the two variables, the data was fitted with a straight line $y = m \cdot x + q$.
The best values for the parameters are:

- $m = 16 \pm 1\ \mathrm{mm}^{-1}$,
- $q = -2.6 \pm 0.3$,

while the covariance matrix for the two is:

$$\begin{pmatrix} 1.068 & -0.302 \\ -0.302 & 0.118 \end{pmatrix}$$

(a) Plot the data and the fitted line.

(b) Disregarding the correlation between the variables m and q, calculate the slope of a beach whose sand grains have the diameter of 1.5 mm. Report the number with the corresponding uncertainty.

(c) Repeat the task of point (b), this time taking into account the correlation between m and q. In which case is the uncertainty on the extrapolated value smaller? Argument your answer.

Deadline for submission: Friday, 6 November 2020 14:00
Form: Please submit your solutions to da@physik.uzh.ch. Solve (1) with pen and paper and attach a scanned version of your answer to the email. The rest of the solutions should be submitted as a single python script.