Numerisches Praktikum – Numerical Practical Training

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Statistics and Fitting

Return by 9:15 a.m. tomorrow

Assignment for the Afternoon / Homework

All data files required for this exercise sheet can be downloaded from the UKNum homepage `http://www.mpia.de/homes/klahr/UKNUM_2015.html`.

- **Exercise 1, 4 points:** Statistics (I).
  The data in the file `dice.dat` (available on the UKNum homepage) represent the results of experiments rolling two dice and adding the pips ("Augenzahl"). The first and second column in the file give the number of the experiment and the result, respectively. **(a)** Write a program code which reads in the data file and calculates the mean, the median and the standard deviation of the data. What is the relative difference between the mean and the median?

- **Exercise 2, 6 points:** Statistics (II).
  The data in the file `grades.dat` represents the grades of an exam (with results between 0 (worst) and 100 (best). The number in the first column stands for the student's number, with his grade given in the second column. **(a)** Find the mean, the median and the standard deviation of the data. **(b)** What is the relative difference between the mean and the median? How does it compare to the result from 1? What does it tell you about the symmetry of the underlying parent distribution of the data?

- **Exercise 3, 10 points:** Least-Squares Fit to a Line
  A student has measured the potential difference (in volts) along a conducting nickel-silver wire using an analog voltmeter. The voltage is measured between the negative end of the wire and various positions along the wire (in cm). Uncertainties in the positions are less than 1 mm and can be neglected. Assume the the uncertainty in the voltage measurement to be the same for each measurement (i.e., set σ_i= 1.0). **(a)** Write a program code to read in the data in the file `data1.dat` and fit a line $f(x) = a + bx$ through the data using a Least-Squares Fit as presented in the Lecture. **(b)** Estimate the standard deviation of an individual measurement using

$$\sigma^2 \sim s^2 = \frac{1}{N-2} \sum (y_i - a - bx_i)^2.$$

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- **Optional Task:** Least-Squares Fit to an Exponential
  The file `data2.dat` contains the measurements of an exponential decay, e.g., of a radioactive element (in some arbitrary units). The last column gives the (constant) uncertainty in each measurement. Fit an exponential function $f(x) = a\exp(bx)$ to the data using **(a)** the *direct* exponential fit as presented in the Lecture. Use a bracketing root-finding algorithm, e.g., bisection. In the current case, initial guesses of $b_1 = -1$ and $b_2 = 0$ do bracket the root $b_\star$. **(b)** Fit a straight line to the linearized equation using a least-squares fit. Compare the result to the exponential fit in (a). Plot the results of (a) and (b) on linear and on logarithmic scale ($\log y$ vs. x) including the errorbars.