# Exercise 1
## Plotting data
**(handed out: 09.04.2025 – hand in: 16.04.2025)**

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Please, send in your solutions as a gzipped tarball or zip file with a distinct name, e.g., `dekon_elig_ex01.tgz`. This tarball should only contain printerfriendly PDFs, source code (e.g., helloworld.cpp), makefiles. Always provide source code as it is, i.e., not as text in a PDF file.

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1. **Task** *Plotting a histogram* (3 P)
   In the file `histo_data.txt` (click on `URL` or `embedded file`) you can find data from a simulation (one "measurement" $x$ per line). Create a *normalized* histogram (i.e. with frequency of occurence on the y-axis) of these data with a bin size of 0.1 together with the corresponding probability density function $\exp(-x)$. The output should be a PDF file.

2. **Task** *Data plotting and transformation* (9 P)
   In an experiment of three series of measurements, the decay of $^{220}$Rn (Thoron) was recorded with help of a Geiger-Müller counter. Determine the half-live $t_{1/2}$ of $^{220}$Rn from the data (click on `URL` or `embedded file`):

   a) Derive and solve the differential equation for the radioactive decay, so that you get

   $$N(t) = N_0 e^{-\lambda t} \ . \tag{1}$$

   Start from the idea that the number of decayed nuclei $-dN$ within a time interval $dt$ is proportional to the number of existing nuclei $N(t)$ with proportionality factor $\lambda$. (2P)
   Also derive the relation between $\lambda$ and $t_{1/2}$. (1P)
   Of course, we cannot simply measure the amount of $^{220}$Rn nuclei, but instead we measure the activity (count rate), why does this yield $t_{1/2}$? (1P)

   b) Use gnuplot or a similar plotting tool with PDF output, to plot the natural logarithm of the count rate (average of the three series) over time. Also plot a linear fit to these transformed data, yielding the half-life $t_{1/2}$. Use for the fit only the relevant data points, where the actual decay is measured, so for time interval $[100 : 300]$s. Do not forget to label axes, data, and curve. Hand in the PDF file. (4P)
   Compare your result for $t_{1/2}$ with literature values (e.g., Wikipedia). (1P)