In the name of God

Department of Physics
Shahid Beheshti University

ADVANCED COURSE ON COMPUTATIONAL PHYSICS

Exercise Set 3

(Due Date: 1403/08/07)

1. Linear fitting function: According to subjects tough in course and based on 'datalinear.txt'" input data including $\{D\} : \{(x_i \pm \sigma_{x_i}; y_i \pm \sigma_{y_i})\}$, such that the column data form left to right correspond to x, y, σ_{x_i} and σ_{y_i}, respectively. Do following tasks:
A : Derive analytically the best fit values for m and c in the case that we take into account σ_{x_i} and σ_{y_i}. Compare your results with that computed by ignoring the associated uncertainties.
B : Write a program to compute the best fit values for $\{\Theta\} : \{m, c\}$ for linear function as $Y_{theo.} = mx + c$. Compare your results with the analytical results given by previous part.
C : Taking into account the σ_{x_i} and σ_{y_i}, determine the σ_m and σ_c.
D : Use a typical software such as Mathematica or Python or whatever you like and compare the results given by mentioned software for linear fitting and your results reported in the previous parts.
E : Plot your data including error-bars for x and y and the fitted function to ensure about the reliability of your results.

2. Error analysis and propagation: Using the "data.txt" file, write a proper program to do following tasks:
A : Read input data file which contains more than 10^6 one-column data. and spilt it to 100 input files.
B : Making directories and send each data set to corresponding directory.
C : compute the PDF ($p_i(x)$,, $i = 1, ..., 100$) of each data sets using Top-Hat kernel for $\Delta x = 0.1$, $\Delta x = 0.01$ and $\Delta x = 0.001$.
D : Compute $\sigma_m(p_i(x))$. Plot $p_i(x)$ versus x and show its error-bar for some of data sets.
E :Then based on smoothing approach, consider $\mathcal{B}(X) = e^{-X^2/2\sigma}$ with $\sigma = 2$, $\sigma = 0.2$ in order to smooth PDF. Explain you results.
E : Compute $p(x(i), x(j))$ and compare it with each one-point probability density function by determining $\Delta(\tau) = \int dx(t)dx(t+\tau)|p(x(t+\tau), x(t)) - p(x(t+\tau))p(x(t))|$. For 5 arbitrary sets plot $\Delta(\tau)$ as a function of τ. Explain your results.

Good luck, Movahed
