In the name of God

Department of Physics
Shahid Beheshti University

ADVANCED COURSE ON COMPUTATIONAL PHYSICS AND OPTIMIZATION

Exercise Set 2

(Due Date: 1403/01/20)

1. 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 mean, variance and mean standard deviation of each data set. And write them in a file which contains the label of data, mean, standard deviation and mean standard deviation. Finally plot them.

2. Suppose that a typical secondary quantity, z is computed by $z = \tanh(x^2) + e^y$. According to data files ("xnew.txt" and "ynew.txt"), determine series for z including corresponding error. Plot all data file. (Hint: each input data file contains 3 columns. The first column is just label, the second column is quantity and third column is error.)

3. 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.

4. Stationary checking: The weak definition of stationary for a time series as $\{x(t), t = 1, ..., N\}$ is evaluating

$$\sigma(\tau) \equiv \frac{1}{M}\sum_{i=1}^{M}\sigma(i)$$

as a function of τ. Here $M = \left[\frac{N}{\tau}\right]$ and $\sigma^2(i) = \frac{1}{\tau}\sum_{t=1}^{\tau}(x_i(t) - \langle x_i(t)\rangle)^2$ and i runs from 1 to M and represents the label of various partitions. Any τ dependency indicates the footprint of non-stationary in underlying series.

A : Compute $\sigma(\tau)$ as a function of τ for "FBM.txt" data.
B : Compute $\sigma(\tau)$ as a function of τ for "FGN.txt" data.
C : Use the FBM.txt data and write a program to generate its increment as $y(t) \equiv x(t+1) - x(t)$ and for new constructed signal, compute $\sigma(\tau)$ and compare your result with part A.

D : Use the FGN.txt data and write a program to generate its profile as $y(t) \equiv \sum_{i=1}^{t} x(i)$ and for new constructed signal, compute $\sigma(\tau)$ and compare your result with part B.

CONTINUED

E : The stationary intensity: Various series may show the different amount of non-stationary properties. In order to compare the intensity of non-stationary of different series, a way is computing associated $\sigma(\tau)$ and plot them in a same figure (log-log plot is recommended). The value of τ for which the $\sigma(\tau)$ would be almost saturated is so-called $\tau_{stationary}$ and for $\tau \geq \tau_{stationary}$ the signal can be considered as stationary regime. For the different data sets ("DataE.zip"), compute corresponding $\tau_{stationary}$ and plot it versus the name of given series.

Good luck, Movahed