In the name of God

Department of Physics
Shahid Beheshti University

ADVANCED METHODS ON COMPUTATIONAL PHYSICS

Exercise Set 6

(Date Due: 1399/01/10)

1. Using the input file, write a proper program to do following tasks. Remember that you have split previous data into 100 part.

A : Compute $p_i(x)$ as a function of x for each sets.
B : Compute $\sigma_m(p(x))$. Plot $p(x)$ versus x and show its error-bar for 5 sets of data.
C : Compute $p(x(i), x(j))$ and compare it with each one-point probability density function by determining $\Delta(\tau) = |p(x(t+\tau), x(t)) - p(x(t+\tau))p(x(t))|$. For 5 arbitrary sets plot $\Delta(\tau)$ as a function of τ. Explain your results.

2. High-pass and low-pass filters:
A: Using random generator of computer, make a time series and then superimpose it with typical periodic function such as $\sum_{i=1}^{10} A_i \sin(2\pi/T_i t)$, where A's and T's are the amplitude and period time scale, respectively. Plot this data.
B: Using Fourier transform, compute power spectrum.
C: In Fourier space, by setting some higher value of Fourier coefficients to zero, make a low-pass filter and then do inverse Fourier transform and compare it with original data.
D: In Fourier space, by setting some lower value of Fourier coefficients to zero, make a high-pass filter and then do inverse Fourier transform and compare it with original data.

3. Alias effect:
A: Make a sinusoidal series according to:

$$x(t) = \sum_{i=1}^{10} A_i \sin(t/i)$$

Compute power spectrum of this data.
B: Now suppose that the sampling frequency for recoding data is: $f_s = 10$Hz, provide a new set of data by mentioned data sampling frequency and determine the power spectrum. Explain your result.
C: Suppose that the sampling frequency for recoding data is: $f_s = 15$Hz, provide a new set of data by mentioned data sampling frequency and determine the power spectrum. Explain your result.

Power spectrum: Using sonspot.txt data which is the number of spots apperaed on the sun as a function of month. Determine the sun activity periods. How many frequencies can be recognized on the power spectrum.

4. Generate Gaussian series whose correlation function is given by $C_x(\tau) = (\tau^2 + 1)e^{-\alpha\tau^2}$. Consider $\alpha = 1$, $\alpha = 2$. To ensure that your generated data sets follow your conditions imposed on data, compute the correlation function and PDF and compare them with expected form.

Good luck, Movahed