In the name of God

Department of Physics
Shahid Beheshti University

OPTIMIZATION METHODS IN PHYSICS

Exercise Set 5

(Due Date: 1400/08/21)

1. Using the input file (data1), write a proper program to do the following tasks. Remember that you must split data into 100 part with equal size.

> **A** : Compute $C(i,j) = \langle x(t_i)x(t_j)\rangle$. To this end, you must do the averaging on the 100 data sets. Make a matrix and plot it as a density plot.
> **B** : Compute $C_i(\tau) = \langle x(t+\tau)x(t)\rangle$ for series and plot it for 5 sets of you data.

2. According to Pearson correlation coefficient, compute the degree of correlation between 0.2.txt and 0.5.txt as well as with themselves.

3. Compute $C(\tau) = \langle x(t+\tau)x(t)\rangle$ for 0.2.txt and 0.5.txt and 0.8.txt data sets. Interpret your results.

4. Non-linear correlation. There are many methods to compute non-linear correlation coefficient. According to Wang, Qiang, Yi Shen, and Jian Qiu Zhang. "A nonlinear correlation measure for multivariable data set." Physica D: Nonlinear Phenomena 200.3-4 (2005): 287-295, and use the Eqs. (1), (2) and (3) of mentioned paper, compute the mutual information between all pairs of 0.2.txt, 0.5.txt and 0.8.txt.

5. Linear and non-linear correlation coefficients. Pearson's coefficient is a familiar measure to quantify the linear-correlation, while for assessing non-linear relation and even to determine the degree of correlation in the presence of outliers the Spearman's correlation coefficient is used. For all available pairs of 0.2.txt, 0.5.txt and 0.8.txt data sets, compute Spearman's and Pearson's correlation coefficient compare your results. Where:

$$\rho_p \equiv \frac{\langle [x-\langle x\rangle][y-\langle y\rangle]\rangle}{\sigma_x \sigma_y}$$

$$\rho_s \equiv 1 - 6\frac{\sum_{i,j} d_{ij}^2}{N(N^2-1)}$$

and $d_{ij} \equiv [Rank(x_i) - Rank(x_j)][Rank(y_i) - Rank(y_j)]$ and $Rank$ means the order of value of variable in a set. Suppose that for $\{x\} : \{20, 100, 30, 50, 160, 10\}$. Then the $Rank(x) : \{5, 2, 4, 3, 1, 6\}$.

6. Un-weighted TPCF:

> **A** : Compute the un-weighted TPCF of peaks for (1+1)-Dimension data set (1d_data.txt) using Natural estimator.
> **B** : Compute the un-weighted TPCF of peaks for (1+2)-Dimension data set (2d_data.txt) and (2d_datab.txt)using Natural estimator.

Good luck, Movahed