Lab 3.Random signals

Abstract

We should get an idea on

- the probability density function (PDF)
- what is a sample function of a random process
- first / second order ensemble averages (moments)
- the concept of stationarity and ergodicity
- the concept of temporal average vs. ensemble average
- the auto correlation / cross correlation as as a higher order ensemble and temporal averages

1. Tasks

Generate ensemble of random signals of the form $x_n(k) = A\cos(2f\pi/k) + BW_n(k)$ [1],

where $W_n(k)$ is normally distributed in [0,1] numbers, A, f, B are determined in the table below.

1. Estimate the linear mean as ensemble average
2. Estimate the linear mean and squared linear mean

[1] An example is here x = np.random.normal(size=(N, K))
x += np.tile(np.cos(2*np.pi/K*np.arange(K)), [N, 1])

No	f	A	B	N
1	300	300.25	299.75	2000
2	400	400.25	399.75	3000
3	500	500.25	499.75	1800
4	600	600.25	599.75	2000
5	300	300.25	299.75	2000
6	600	600.25	599.75	2000
7	400	400.25	399.75	3000
8	500	500.25	499.75	1800
9	600	600.25	599.75	2000
10	300	300.25	299.75	2000
11	200	200.25	199.75	2000
12	400	400.25	399.75	3000
13	500	500.25	499.75	1800
14	600	600.25	599.75	2000
15	500	500.25	499.75	2000

Table 1: Variants

3. Estimate the quadratic mean and variance.
4. Plot 1-4 graphically.
5. Estimate and plot the auto-correlation function (ACF)

Variants

Reports in the form:

1. Report (file .pdf)

2. file .ipynb

3. pdf-export the file .ipynb

upload to the remote repozitorium (e.g. Github) and link save in the report. Upload the report to eLearning.ubb.edu.pl.

References

References

[pandasUG] Pandas User's Guide `https://pandas.pydata.org/pandas-docs/stable/user_guide/index.html`

[DA2016] Data Analysis with Python and pandas using Jupyter Notebook https://dev.socrata.com/blog/2016/02/01/pandas-and-jupyter-notebook.html

[MIT] https://ocw.mit.edu/courses/res-6-008-digital-signal-processing-spring-2011/pages/study-materials/