EECS240: Random Process

Project #2

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Abstract

This is a computer project running in Python simulating the Random Process with a concentration in Autoregressive (AR) random processes.

The simulation result is given as screenshots, and the corresponding parameters are given ahead of each of the graphs. The code for generating the graphs is omitted due to the limitation of space. For the entire code, please visit: https://github.com/SimonSongCA/EECS240.git.

This GitHub link contains the former project (The EECS 240 Project-1), and you should click the 'Project2' folder for the full Python code of the Project-2.

The 'eecs240_proj2_prob1.py' contains all the code of Problem1, and 'eecs240_proj2_prob2.py' contains the all the code of Problem2.

For the Problem1 code, it's the best if you could run section by section since the code is segregated with comment lines indicating which part of code belongs to which part of the problem.

For the Problem2 code, just run the code directly since the problem only contains one section.

Please feel free to leave comments under the repository webpage about your thoughts, and any idea regarding the improvement of the code is welcome.

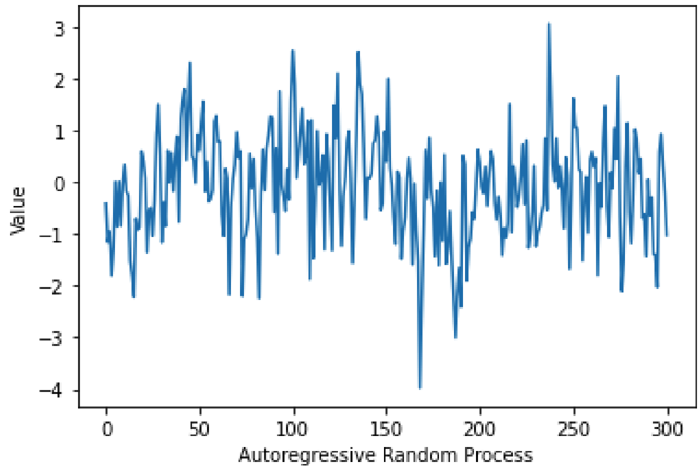
Problem1:

Consider an autoregressive (AR) random process $Y_n = \alpha Y_{n-1} + X_n$ where X_n is a White Gaussian noise with zero mean and variance σ_X^2

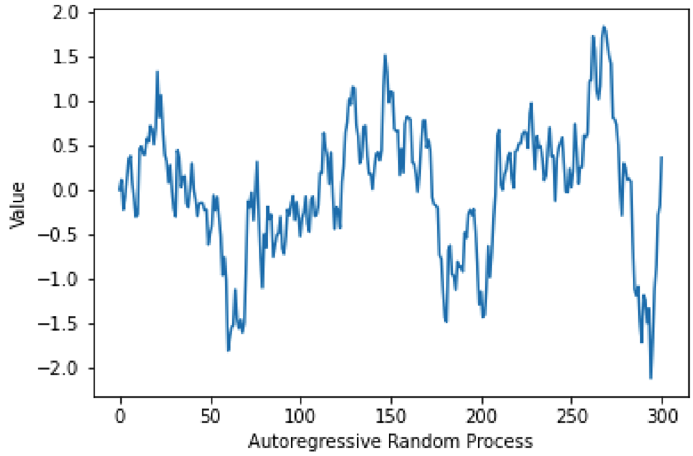
(a) Plot some sample realizations of the above AR random process when $\sigma_X^2 = 1-\alpha^2$, for example for $\alpha = 0.3$ and $\alpha = 0.95$.

Result

Situation1:($\alpha = 0.3$)



Situation2:($\alpha = 0.95$)



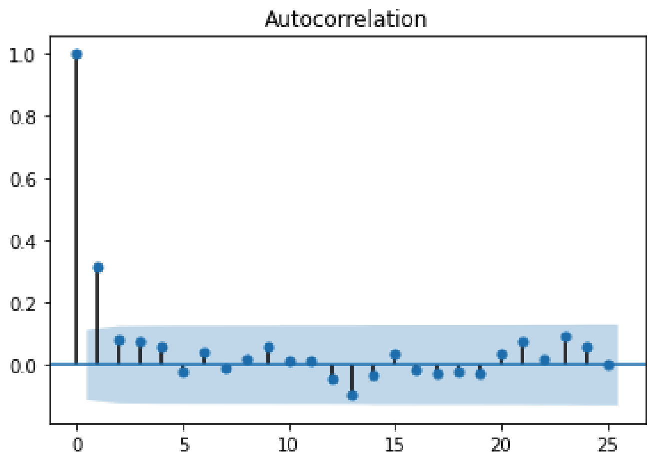
Analysis

The two AR processes with different parameters $\alpha = 0.3$ and $\alpha = 0.95$ has different results. 300 times random numbers were generated to form the AR random process. From the generated figures, a lager α demonstrates a more stationary characteristic while a smaller α demonstrates a more fluctuate pattern. The conclusion in this section is that: with α becoming smaller, the AR random process is getting more stationary.

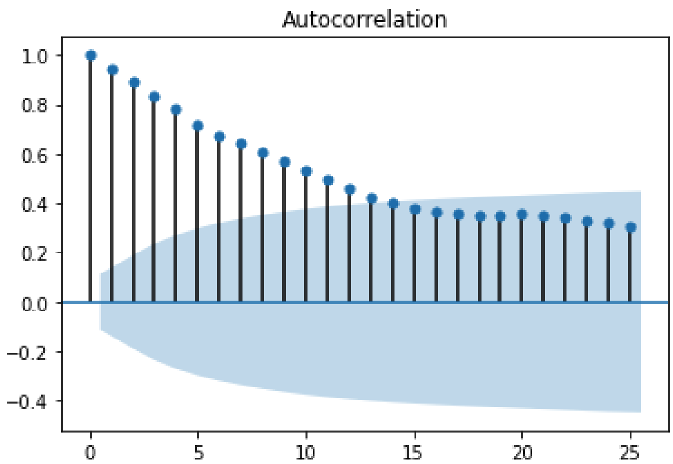
(b) Simulate and plot the autocorrelation $R_Y(k)$ for $\alpha = 0.3$ and $\alpha = 0.95$.

Result

Situation1:($\alpha = 0.3$)



Situation2:($\alpha = 0.95$)



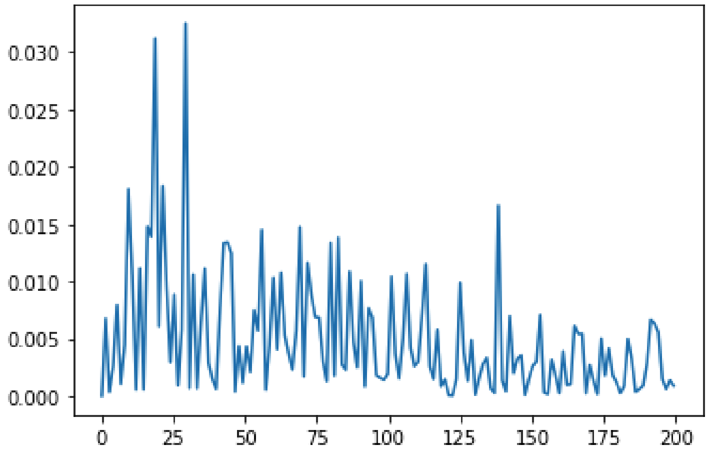
Analysis

From the graphs, the two autocorrelation graphs showed two different patterns. The first one is Autocorrelation RY (k) with parameter $\alpha = 0.3$, and the limits is from 0 to 300. It shows that a smaller a is giving a more fluctuate pattern, while the one with a=0.95 shows a smoother pattern.

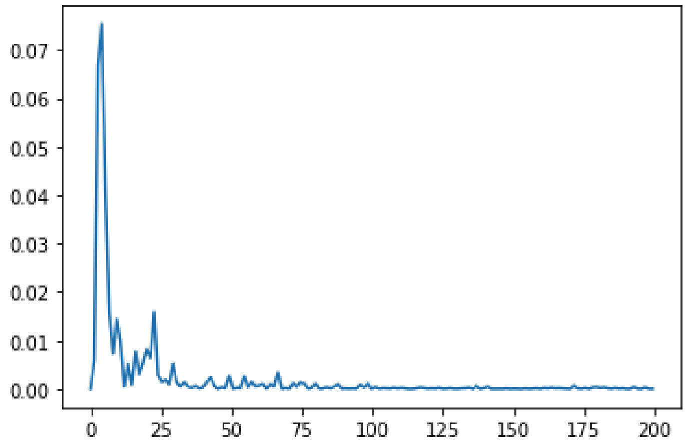
(c) Simulate and plot the power spectral density SY (f) for α = 0.3 and α = 0.95

Result

Situation1:(α = 0.3)



Situation2:(α = 0.95)



Analysis

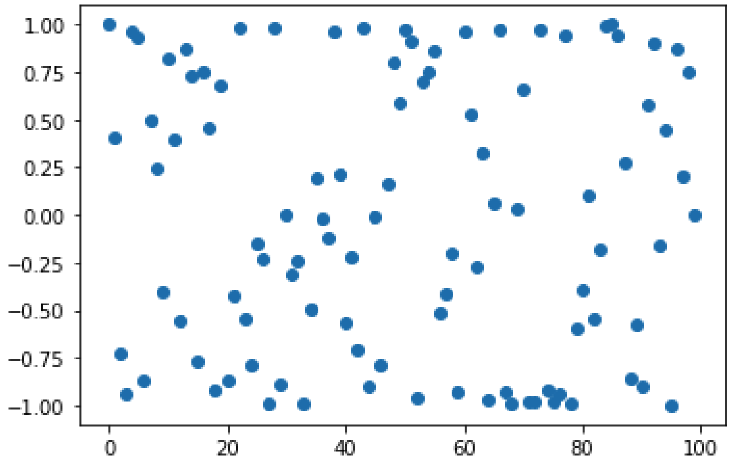
From the graphs, the power spectral density with smaller α looks like being distributed evenly and the lager α concentrates around the frequency between 0 to 25Hz.

The conclusion is: with the α becomes bigger, the power spectral density would be compressed within a smaller interval.

Problem2:

Consider the random process $X_n = \cos(0.2\pi n+\Theta)$ where Θ is a uniform random variable between $(-\pi, \pi)$. Draw one plot that contains 100 different realizations of X_n versus n (all in one plot). Use a dot to represent every (n,X_n) pair in the 2D plane.

Result



Analysis

In this problem, we first generated a uniform random variable and then form the required random process. At every different time n, we are having different RVs and we plot it in the 2D plane.