Applications of correlation and autocorrelation

Laboratory 2, DEPI

Objective

Students should become familiar with using correlation and autocorrelation of signals

Theoretical aspects

Exercises

1. Generate the following signals and compute their autocorrelation with `xcorr()`:

   a. $x[n] = sin(2\pi f n)$, with $f = 0.01$, and 1000 samples
   b. a sequence of random noise with gaussian distribution (`randn()`)
   c. a sequence of random noise with uniform distribution symmetrical around 0 (`rand()`)

   What is the interpretation of the autocorrelation function for each case?

2. Simulate threshold-based detection with a single sample, as follows:

   - Generate a vector of 100000 values 0 or A, with equal probability (hint: use `rand()` and compare to 0.5)
   - Add over it a random noise with normal distribution $\mathcal{N}(0, \sigma^2 = 1)$
   - Compare each element with T to decide which sample is logical 0 or logical 1 (A)
   - Compare the decision result with the true original vector, and count how many correct detections and how may false alarms have been.
   - Estimate P(hit) and P(false alarm) by dividing the above numbers to the size of the vector

3. Wrap the above code into a function `[phit, pfa] = myThreshDet(T)` that returns the two probabilities for a given `T`. Draw the ROC by running the function for 100 values of T uniformly spaced between 0 and A, and plotting the resulting vector `phit` against `pfa` (

4. Repeat the same simulation for two samples per bit:
   - double the values of the starting vector, making two consecutive 0 or A values, e.g.
   $$[00AA00AAAA00AA...]$$
   - the decision now uses **the average value** of the two consecutive samples of a bit
   - plot the ROC and compare with the first one. Which is better?

Final questions

1. In a practical scenario, what is the disadvantage of using 2 samples for detection, compared to just 1?