# Exercise 0

Denne opgave er mere intuitiv, og kræver at i selv ser på selve resultaterne af example.py. Derfor giver jeg ikke svaret her.

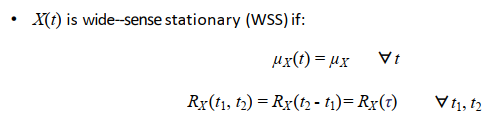
# Exercise 1

**Download exercise1.py and ecg.xlsx from the lecture material directory. The script defines a template of one ECG beat. Use the template together with the cross-correlation to find the location of all heart beats in the ECG. Then, based on these locations align the beats (e.g. in a n by 70 matrix, where each row is an aligned heart beat), and use the aligned beats to form a mean or median beat.**

(**exercise1\_sol.py**) in the lecture material folder with an example of how the autocorrelation function can be used to align heart beats based on a template. The comments in the file should explain the process. If there is anything that is unclear, please let me know by asking about it.

# Exercise 2

**Consider an EMG signal detected with additive noise. The EMG signal and the noise are WSS stochastic processes with zero mean. They are independent. The EMG signal has known autocorrelation function and the noise has autocorrelation function . Let the summation of the EMG signal and the noise be Y(t), determine the autocorrelation function of . Is WSS?**

For Y(t) to be WSS, the following needs to be true:

* *It does not take much to evaluate that , because N and X are independent*
* *To test that*

*And expanding the equation:*

*When ever two processes are independent, the following holds true , which means*

*So*

***Y(t) is WSS! Because , and***

# Exercise 3

**Consider a stochastic process with uniform distribution of the amplitude between and . The variance of is . The samples of are independent from each other. . is a random variable with uniform distribution in the interval . is independent of .**

***Compute mean, autocorrelation, autocovariance, and variance of the stochastic process,***

**Hint1:**

**Hint2: can be solved using integration by substitution.**

* **Mean** of Y

Because X and \phi are independent

* **Autocorrelation**

Because , and , we get the following equation

Understanding why is a bit cumbersome. This is not something you would see in an exam but would be provided as a hint. However, this is why:

We use integration by substitution:

Define , so to differentiate t with respect to , we get

Since , the uniform pdf is , and because and are constants:

Hence:

* **Autocovariance**

The covariance is defined as :

We already know that , and we have defined , so

* **Variance**

We can define variance as

Again, , so:

# Exercise 4

**Consider an EEG signal with known autocorrelation function and zero mean. The signal is filtered by a filter with impulse response . Find the mean and autocorrelation function of the output signal.**

**To solve exercise 4, we must know:**

* **the what the convolution integral:**
* **the sifting property due to the two dirac impulses:**

So for the first conv :

And for the second conv:

Simplifying

**Mean**:

**Autocorrelation**: